NSW Treasury

TPG23-08
NSW Government Guide to Cost-Benefit Analysis

February 2023

Acknowledgment of Country

We acknowledge that Aboriginal and Torres Strait Islander peoples are the First Peoples and Traditional Custodians of Australia, and the oldest continuing culture in human history.

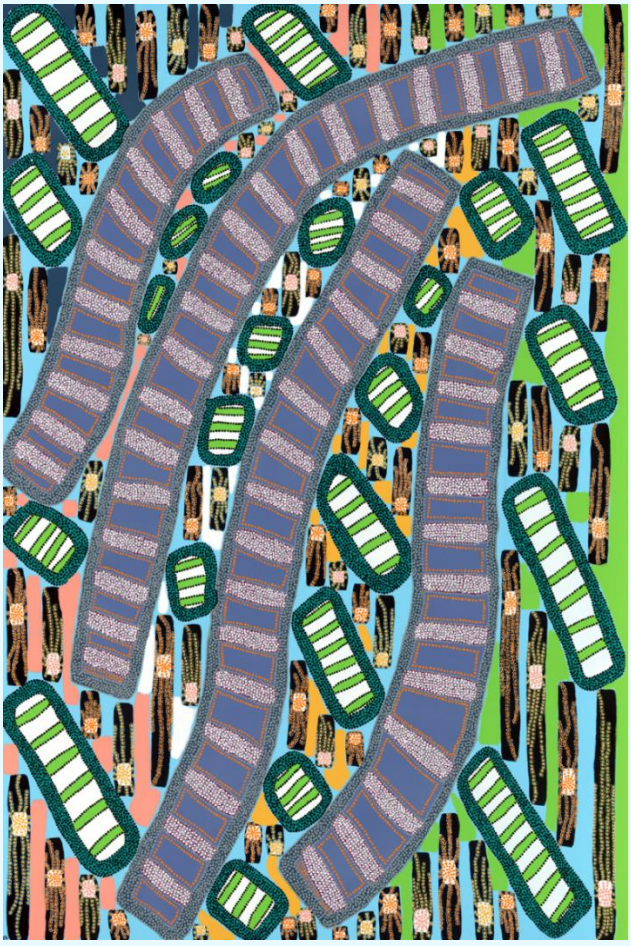
We pay respect to Elders past and present and commit to respecting the lands we walk on, and the communities we walk with.

We celebrate the deep and enduring connection of Aboriginal and Torres Strait Islander peoples to Country and acknowledge their continuing custodianship of the land, seas and sky.

We acknowledge the ongoing stewardship of Aboriginal and Torres Strait Islander peoples, and the important contribution they make to our communities and economies.

We reflect on the continuing impact of government policies and practices, and recognise our responsibility to work together with and for Aboriginal and Torres Strait Islander peoples, families and communities, towards improved economic, social and cultural outcomes.

Artwork:
Regeneration by Josie Rose



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NSW Government Guide to Cost-Benefit Analysis

Purpose

This NSW Government Guide to Cost-Benefit Analysis (the Guide) is a Treasury Policy and Guidelines paper that sets out how to undertake cost-benefit analysis (CBA) for NSW government initiatives. It also describes the role of CBA in supporting evidence-informed decision making and provides guidance for practitioners. It is central to the NSW investment framework for the appraisal and evaluation of public investments.

CBA is the preferred method for appraising the economic, social, environmental and cultural value of all government policies and proposals. This is because it captures a comprehensive range of costs and benefits — such as leisure time, carbon emissions, culture and natural resources — that are not reflected in standard economic measures such as Gross State Product or average income. It also allows the comparison of the efficacy of initiatives across all government activities.

The purpose of this update to the Guide is to improve clarity, consistency, ease of use and update key parameters. The update also reflects current theory and practice that may have evolved since the last edition.

Audience

The Guide is structured to accommodate a range of audiences:

- Chapter 1 provides an accessible overview of CBA for a general audience.
- Chapter 2 outlines the steps involved in completing a CBA, with some technical information. It will be useful for managers supervising CBA, analysts learning to undertake a simple CBA and experienced analysts looking for the specific expectations for CBA for NSW Government.
- The Appendices are reference documents addressing specific technical issues. They are intended to be an 'as needed' resource for analysts undertaking CBA.

Overview

- CBA is an evidence-based, systematic and comprehensive economic analysis that aims to measure the full impacts of government decisions on New South Wales, including economic, social, environmental and cultural impacts.
- The purpose of CBA is to support decision makers to enhance community welfare.
- The Guide establishes some mandatory requirements for CBA, which are clearly indicated. Most of the Guide consists of recommendations and guidance for best practice CBA.
- Where Governments face significant decisions, CBA can be a valuable tool for formulating initiatives prior to a business case or where a business case is not required.
- The scale and detail of CBA should vary with the scale and significance of the proposal for decision.

The Guide promotes a consistent approach to CBA of projects, programs, policies and regulations — referred to collectively in the Guide as **initiatives** — across the NSW Government. The Guide applies

to all General Government Agencies and non-commercial Public Non-Financial Corporations[1] — referred to in the Guide as **agencies**.

Summary of Requirements

CBA is used in variety of contexts to inform development of initiatives and Government decision-making, such as grants programs and internal agency prioritisation processes. This Guide supports broad use of CBA but does not make it mandatory to undertake CBA in these situations. A separate agency or Treasury direction or policy may make CBA mandatory in some situations.

CBA is also used to evaluate initiatives after they have been implemented, known as ex post CBA. Treasury's Policy and Guidelines: Evaluation (TPG22-22) sets the expectations for when ex post CBA should be undertaken.

Mandatory

When cost-benefit analysis (CBA) is required:

It is **mandatory** to undertake CBA when producing a business case to support a government funding or regulatory proposal.[2] CBA is thus required for capital, recurrent and information and communications technology (ICT) proposals with an estimated total cost of $10 million or higher.

Note, this cost threshold is set by Treasury's Submission of Business Cases (TPG22-04).

Mandatory features of CBA:

CBA in business cases is required to:

- clearly and concisely define the problem, or opportunity, that the initiative is attempting to address, and how it will work
- define a base case and present CBA results relative to the base case
- assess at least two realistic options (in addition to the base case)
- estimate benefit-cost ratio (BCR) and net present value (NPV) results for the NSW referent group for each option
- use the central social discount rate set in the Guide (5 per cent real) to produce the central BCR and NPV results
- undertake sensitivity analysis on the BCR and NPV results for key risks and for the social discount rate sensitivities set in the Guide (3 and 7 per cent real)
- provide a distributional analysis of the initiative (this can be quantitative, qualitative, or a combination of both)
- include an 'executive summary' that summarises:
    - the intended purpose of the initiative
    - key features of each option and the base case

1 In cases where Public Financial Corporations or commercial Public Non-Financial Corporations (e.g., State Owned Corporations) prepare business cases for consideration by Government, they should apply the Guide (see TPP18-05 Major Projects Policy for Government Businesses).

2 Unless Treasury has agreed that cost-effectiveness analysis may substitute for CBA for a specific business case.

Mandatory

- central BCR and NPV results for each option, including a breakdown of the value attributed to each key cost and benefit stream
- significant costs and benefits that could not be quantified and an estimate of their expected impact
- BCR and NPV results of key sensitivity analyses
- key risks and distributional impacts decision-makers should consider.

CBA produced for purposes other than business cases are subject to the same requirements, but agencies may make reasonable adjustments to reflect the purpose of the CBA. For example, in some cases, such as grant programs or an *ex post* CBA, it may be appropriate to assess only one realistic option.

Key changes from previous edition

This Guide primarily makes incremental improvements to clarify and update previous guidance. Key changes include:

- The central real social discount rate has changed to 5 per cent from 7 per cent, with mandatory sensitivity analyses now at 3 per cent and 7 per cent.
- Mandatory requirements are clearly articulated and presented in one place, under 'Summary of Requirements'.
- The Guide now lists eight steps to CBA, rather than nine. The former ninth step, 'Undertake post evaluation', is presented alongside the eight steps to be clear that evaluation is a critical activity that is separate to *ex ante* CBA. The preceding eight steps have been re-organised for clarity and flow.
- Further guidance provided on carbon pricing and the need to account for carbon emissions, consider environmental impacts and consider climate risk in CBA.
- The benefit-cost ratio formula has been adjusted to reduce ambiguity in its application (Appendix 7).
- More detailed technical guidance has been developed on considering risk and uncertainty (Appendix 4) and distributional analysis (Appendix 5).

1 Overview of Cost-Benefit Analysis

1.1 What is cost-benefit analysis (CBA)

Cost-benefit analysis (CBA) is a holistic appraisal method that estimates the economic, social, environmental and cultural costs and benefits of an initiative and expresses them in monetary terms.

CBA aims to measure the full impacts of any government decision or action on the households, businesses, governments, non-government organisations and natural assets in a specified community, known as the referent group. In this Guide, the referent group comprises the residents of New South Wales.

CBA measures the costs and benefits attributable to an initiative relative to a business-as-usual situation without the proposed initiative. The business-as-usual situation is known as the base case.

It tallies up all the costs and benefits attributable to an initiative to estimate the net impact on social welfare. This impact is presented in benefit cost ratio (BCR) and net present value (NPV) estimates.

- BCR is the ratio of benefits to costs (i.e., benefits divided by costs).
- NPV equals benefits minus costs.

To **compare** costs and benefits, CBA uses a monetary (dollar) metric to place different types of costs and benefits on a common scale. Putting a monetary value on non-market items such as travel time savings, or the environment enables the comparison of costs and benefits across policy domains.

Crucially, CBA is not limited to counting outcomes that have financial impacts, produce measurable cash-flows, or contribute to Gross State Product. Nor does expressing an outcome's value in dollar terms imply that outcome could be (or should be) bought or sold. This Guide describes how both non-market and market impacts can be identified and valued in dollars.

Costs and benefits of initiatives occur over different time periods but need to be compared on an even footing. CBA uses a **social discount rate** to convert future costs and benefits into **present values**, that is the value of those things today. The social discount rate reflects the fact that a benefit now is worth more than one in the future, as monetary resources could be alternatively invested and accrue returns in the meantime.

Overall, a CBA reports whether the benefits of a proposal are likely to exceed the costs, and which option among a range of options is expected to result in the highest **net social benefit**. On this basis, CBA can be used to support Government in determining the initiatives that offer the best value for money for the community. In other words, CBA enables governments to assess which initiatives provide the greatest improvements in community welfare for a given investment.

Figure 1.1 illustrates these concepts through an example of a CBA results table, taken from the published business case summary for the Children's Hospital at Westmead Stage 2 Redevelopment.[3]

3 Business case summary published by Infrastructure NSW, available at: https://www.infrastructure.nsw.gov.au/investor-assurance/business-case-summaries/

Figure 1.1 – Example of CBA results: Children's Hospital at Westmead Stage 2 Redevelopment

All values are incremental to base case, present value ($2020-21 million)

	Option 1a	Option 4
Improved inpatient services	1,381.5	1,435.0
Improved cancer services	84.5	84.5
Car park benefits	5.5	5.5
Avoided operating inefficiencies	-	4.7
Residual value of assets	84.8	86.8
Total benefits	**1,556.2**	**1,616.5**
Capital costs	433.2	442.4
Operating costs	678.2	684.7
Repairs, maintenance and replacement costs	53.0	51.7
Life-cycle capital maintenance costs	21.2	21.2
Total costs	**1,185.5**	**1,200.0**
Net present value (NPV)	**370.6**	**416.5**
Benefit cost ratio (BCR)	**1.31**	**1.35**

The results in Figure 1.1 indicate that both options were expected to deliver a net benefit to New South Wales. The CBA pointed to Option 4 as being preferred because, while it was more expensive, it was expected to deliver a greater net benefit, both in absolute and relative terms and therefore represented better value for money.

Features of CBA

Identifying and **forecasting** the impacts of an initiative often involves work by specialists in various fields. It is sometimes difficult to forecast or place monetary values on all impacts with confidence.

This Guide recommends **including all significant costs and benefits quantitatively and valued in dollars where possible** in the CBA result, drawing on the best evidence available and outlining assumptions and data limitations.

Where it is not possible to quantify potentially significant costs or benefits, they should be **described qualitatively** and reported in the CBA results section alongside the quantified results.

Even when impacts are difficult to quantify, CBA remains a systematic and valuable method for organising information.

Distributional analysis should be included in CBA reports to indicate which groups bear costs or receive benefits.

Sensitivity analysis tests the results of the CBA by varying key assumptions to reflect risks and uncertainties. It is a critical part of CBA.

1.2 How does CBA help decision makers?

CBA is an invaluable resource allocation tool because it allows decision makers to compare initiatives between portfolios on the same basis. Where there is a budget constraint and competing initiatives, CBA can help rank projects to maximise community welfare.

It allows decision makers to distribute resources to achieve the greatest welfare gain with the available funding — or, in other words, the best value for money. CBA can help decision makers by:

- clearly articulating the problem, or opportunity, the initiative is designed to address and presenting alternative solutions
- allowing systematic comparisons of the costs and benefits of different options to most improve social welfare
- scoping and shortlisting options in the early initiative development phase
- prioritising or ranking different options to meet an objective with constrained resources
- promoting consistency in decision making and the assessment of relative priorities
- enhancing transparency by using a consistent method that allows assumptions and scenarios to be tested.

CBA can provide decision makers with valuable insights when considering initiatives and help them to maximise community welfare in an environment of constrained resources. CBA also supports the comparison of alternative options to achieve an objective, or to **maximise community welfare in an environment of constrained resources**.

Related guidance

This Guide forms part of the investment framework, a suite of Treasury policies and guidelines that supports Government to make evidence informed policy and investment decisions. This Guide should be considered alongside the:

- NSW Government Business Case Guidelines (TPP18-06)
- Policy and Guidelines: Evaluation (TPG22-22)
- NSW Government Guide to Better Regulation (TPP19-01)
- Benefits Realisation Management Framework
- NSW Gateway Policy (TPG22-12)
- Outcome Budgeting (TPP18-09).

While agencies have developed sector-specific CBA guidelines, often developed jointly with Treasury, this Guide sets the overarching, principles-based CBA framework. Agency- or sector-specific CBA guidelines provide additional methodologies and details, **in line with the principles in this Guide**, that are invaluable in the practical preparation of CBAs. Publicly available sector-specific CBA guidelines are listed in Appendix 10.

1.3 When should CBA be used?

Throughout the process of initiative development

CBA is valuable at all stages of initiative development. The process and discipline of CBA thinking helps to clarify problems and opportunities, establish the need for an intervention, identify stakeholders (beneficiaries or groups bearing costs) and define and compare options.

CBA is also recommended for high-risk initiatives not requiring a business case, for example a pilot project, and CBA may be valuable for developing strategies or programs.

As part of business cases

CBA is a mandatory part of a business case, which is required for capital, recurrent and ICT proposals with an estimated total cost of $10 million or higher.

Submission of Business Cases (TPG 22-04) sets out when a business case is required, and NSW Government Business Case Guidelines (TPP 18-06) establishes requirements and recommendations for producing business cases.

CBA is required in both strategic (pre-investment decision) and detailed (investment decision) business cases. CBA in a strategic business case typically contains a broader range of options and less detailed cost and benefit estimates. The CBA should then be updated at subsequent stages as more information comes to hand and the process move closer to an investment decision.

Both before and after initiative implementation

CBA in business cases is typically *ex ante*, that is, undertaken before the initiative is implemented and therefore based on forecasts rather than observed results. This Guide is focused on the conduct of *ex ante* CBA.

CBA can also be conducted *ex post*, that is, after an initiative is implemented and using observed data (possibly combined with forecasts). *Ex post* CBA is a critical part of evaluation and is discussed in more detail, including when it should be undertaken, in Policy and Guidelines: Evaluation (TPG22-22). The principles of CBA are consistent between *ex ante* and *ex post* applications.

After a case for change has been established

A clear case for change should be identified before undertaking CBA. The case for change clarifies the problem the intervention is designed to address and establishes the need to act, while the CBA compares the merits of different courses of action.

The case for change identifies the underlying community need (a problem or opportunity), or gap in current service provision, or regulatory arrangements, the initiative will address. It should be based on the need to resolve a market failure, address equity concerns or take a necessary action to achieve government objectives.

- Market failure is a situation where the private market fails to supply a socially optimal level of a good or service (discussed further in Appendix 9).
- Equity concerns include supporting disadvantaged groups.

- Objectives are expressed in State Outcomes and Premier's Priorities, legislation, strategies, targets or election commitments.[4]

For all types of initiatives

CBA is applicable to recurrent, capital, ICT and digital, and regulatory initiatives. Table 1.1 shows examples of a range of problems where CBA has been applied.

Table 1.1: General examples of applications of CBA

Infrastructure	Social programs	Recurrent expenditure	Policies and regulations
Transport: roads, railways, ports and airports	Health care: hospitals, mental health care	Public health programs; subsidies for medicines	Environmental regulations
Utilities: water supply, power	Vocational education and training places	Determining class sizes	Safety regulations: pharmaceuticals, foods
Communications: telephone, broadband	Early childhood programs	Random breath testing for vehicle drivers	Urban planning
Environment: renewable energy	Emergency services and disaster assistance	Location of government offices	Deregulation of taxis, food carts, e-scooters

Cost effectiveness analysis as an alternative

In some circumstances, a cost effectiveness analysis (CEA) may be included in a business case in place of a CBA. CEA is a method of comparing the costs and benefits of different options that achieve the same outcome.

Because it is not possible to use this method to compare initiatives across different outcomes or policy areas, its use should be limited to cases where it is not technically possible to monetise the main benefits. The use of CEA should be discussed with Treasury on a case-by-case basis. CEA is discussed in more detail in Appendix 8.

1.4 Limitations of CBA

CBA is widely used by government, including in all the Australian States and the Commonwealth, the United Kingdom, European Union and New Zealand, as the first-best and preferred method to assess the merits of proposed government policies and public expenditure. As with any analysis, there are limitations to CBA.

4 State Outcomes articulate the primary purpose for which public resources are invested. They are declared in the NSW Budget for each cluster (see Budget Paper No. 2 – Outcomes Statement). Premier's Priorities represent the government's key policy priorities and include targets against each priority (see https://www.nsw.gov.au/premiers-priorities).

There is no single, objective welfare function that can maximise outcomes for the whole community — values still play a critical role in government decision making. It is therefore important to acknowledge that CBA in isolation should not dictate Government decision-making or agency recommendations.

The impact of uncertainty, distributional analysis and significant unquantified costs or benefits should be considered within the CBA, and factors such as deliverability, financial and commercial considerations, resilience, fit with Government strategy and community expectations are considered by agencies and decision makers alongside the CBA (generally within the business case).

Quantifying the full spectrum of outcomes

CBA aims to quantify all benefits and costs to the referent group in monetary terms to allow holistic comparisons. Treasury and agencies work together to continuously improve CBAs to capture a diverse range of outcomes.

In practice, it is challenging to quantify and forecast all outcomes. The established methodologies for CBA are more advanced and standardised (and sometimes more amenable to monetary valuations) for some types of outcomes than others. In some cases, a robust evidence base on the effectiveness of an initiative can exist without that evidence being easily transferrable to CBA results, for example, the mental health benefits of access to green space.

When it is not feasible to quantify and place a dollar value on an important cost or benefit, it should be **described qualitatively and presented in the CBA report** alongside the BCR and NPV.

Distributional and equity concerns

CBA results are aggregated for the whole referent group, meaning BCR and NPV in isolation do not illuminate equity concerns and distributional impacts within the referent group. Including **distributional analysis** within the CBA transparently sets out which groups are impacted and how gains and losses are distributed between groups (see Appendix 5). Distributional analysis can be qualitative and can reference stakeholder experiences and community feedback for additional context.

Resource intensive analysis

CBA can be a relatively data-intensive and specialised form of analysis that usually requires experienced CBA practitioners. Therefore, it is important that the level of detail in a CBA is **proportionate to the size, cost, strategic priority and risk of the initiative**, as well as the stage of initiative development (e.g., CBA to support an investment decision would be more detailed than CBA at the strategic business case stage).

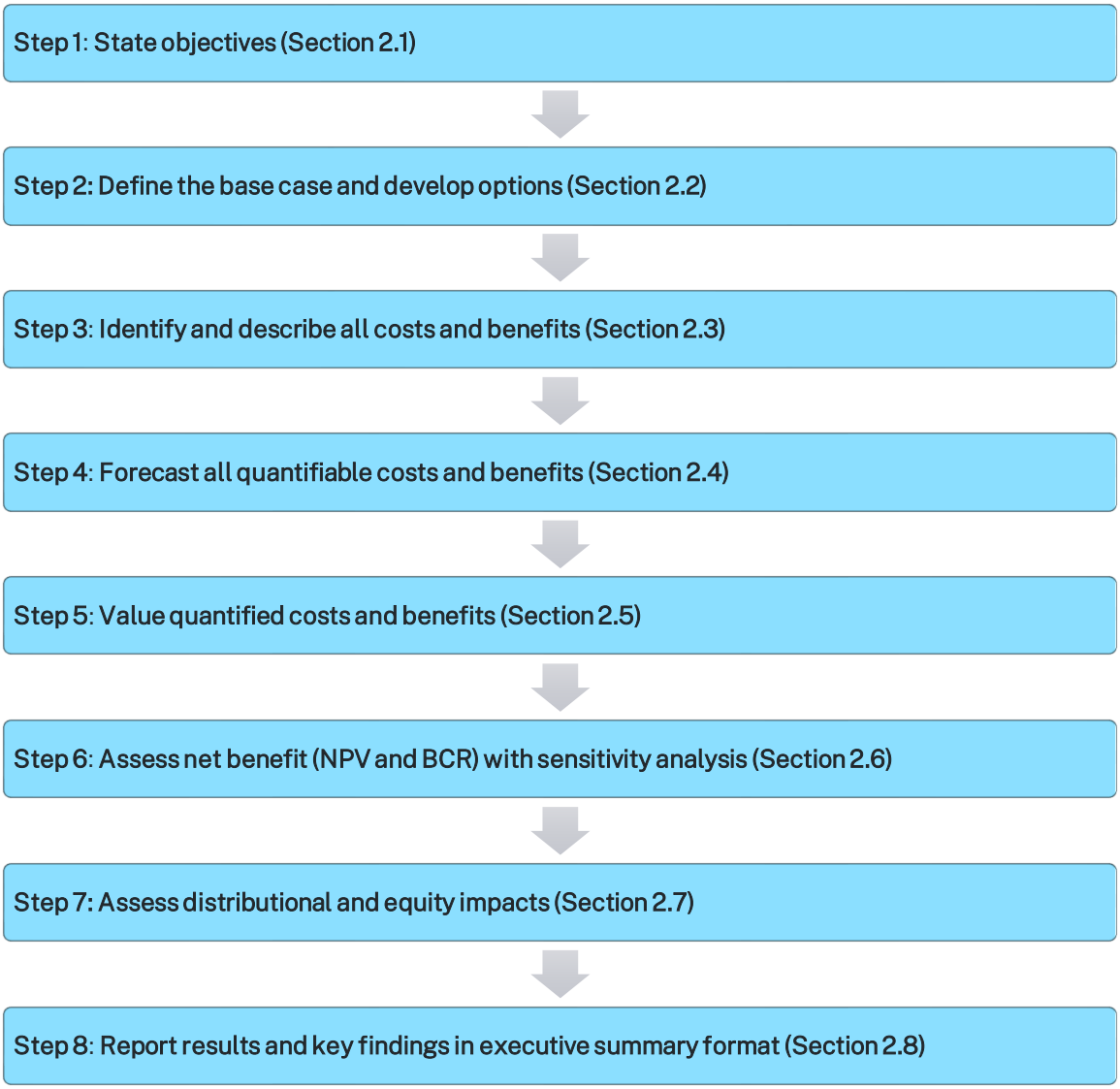
A less detailed CBA may rely more on desktop research or not quantify minor benefits. Conversely, a more detailed CBA may undertake primary research, such as surveys or field interviews, or use more data-oriented modelling techniques.

2 Steps in cost-benefit analysis

Recommendation(s)

- Agencies preparing a CBA should follow the eight steps described in Figure 2.1.
- The steps are sequential. The process of completing a CBA may, however, involve iteration and feedback loops between steps.
- There is no required template for presenting a CBA, but it will often be useful to structure the CBA report in line with the recommended steps in this Guide.

Figure 2.1: Eight steps to undertaking a Cost-Benefit Analysis



2.1 State objectives

The starting point for CBA is to specify the intended objectives and outcomes of the initiative. The objectives should flow from addressing the problem or opportunity identified in the case for change.

Objectives should be stated clearly in terms of welfare outcomes and not be tied to specific outputs.

- Examples of objectives in outcome terms: improve quality of life for people living with a chronic illness, reduce congestion in CBD, protect the natural assets and biodiversity in an area.
- Examples of objectives tied to specific outputs: deliver a particular medical procedure 1,000 times, build a new tunnel from A to B, plant X number of trees.

An initiative's objectives should demonstrate a strategic fit with Government's high-level objectives, typically shown through **alignment with State Outcomes, Premier's Priorities, legislation, strategies, targets or election commitments**.

Strong objectives will be broad enough to allow innovative option design but focused enough to support streamlined, efficient option design.

Revisiting the case for change may help to clarify objectives, as they will often be directly linked to the problem or opportunity the initiative is addressing.

2.2 Define the base case and develop options

CBA needs to establish and clearly define:

- a realistic **base case** to be used as a comparator to the initiative options, and
- a range of **realistic options** to be assessed.

Role of the base case

The benefits and costs of all options are calculated relative to the base case, i.e., the incremental change. Therefore, if the costs of all options exceed the benefits, then the base case is the strongest performing option.

Comparing options to a base case is necessary to isolate the outcomes directly attributable to the option. If we simply estimated gross outcomes over time after the option starts, we would mistakenly credit the option for delivering some changes that would have occurred anyway:

- Pre-existing trends and exogenous factors, such as population growth and climate change, will change outcomes over time whether the option goes ahead or not.
- Other initiatives may cause changes in the same outcomes the option targets. For example, the effect of a road safety education campaign on crash outcomes needs to be separated from the effect of unrelated road network improvements, or improvement in vehicle safety, by comparing to a base case that includes those improvements.

A well-established base case is the foundation for analysing the relative merits of options. An incorrect or loosely specified base case can bias the analysis of options:

- A base case that leaves out positive changes or adaptive measures likely to occur without an intervention may result in overstated option benefits.
- Alternatively, a base case that underestimates the potential for a problem to become more severe over time without intervention may understate option benefits.

Defining the base case

CBA should compare the state of the world *with* each option against the state of the world *without* the option. **The base case is the projection of costs and benefits if none of the options proceed**.

The base case is a 'business as usual' situation. It assumes Government policies remain as they are and generally retains the *status quo*. That is, continuation of current quantity and quality of services including planned maintenance and usage. Table 2.1 describes some common features of base cases for different types of initiatives and Box 2.1 suggestions useful questions to ask in defining a base case.

Table 2.1: Typical base case characteristics

Initiative	Typical base case characteristics
Capital / infrastructure	• No new infrastructure built unless already funded and committed. • Existing infrastructure maintained according to current funding commitments or at the minimum level to remain safe and operating.
Recurrent	• Funded and committed programs continue. • Programs required to meet legislative requirements should continue in the base case. • Where there is uncertainty around funding or service delivery, there may be a need to rely on assumptions.
Regulation	• Existing Acts, regulations and other instruments continue, subject to sunset provisions.
Asset replacement	• May involve deferral of replacement and continued maintenance. • End-of-life assets typically replaced (with a new asset of comparable standard) if required to remain safe and operating.
System augmentation or expansion	• Continuation of the existing system or policies, including maintenance.

Box 2.1: Questions to ask when defining the base case could include:

- Will demand for the service grow or decline over time?
- Are any realistic adaptive measures or minor improvements likely to occur?
- Are there any currently underused assets in the system that could take on more usage?
- Is a significant investment required to keep the current system operating safely?
- What benefit streams will continue into the future? Will these grow or decline?
- How will longer term trends such as changing demographics or climate change affect assets, services or behaviours?

Other initiatives or policy changes that are **committed and funded** but have yet to commence should form part of the base case.

CBA of some long-term initiatives may need to make assumptions about initiatives that are not yet committed and funded to present a realistic future in the base case. These assumptions should be the minimum required to achieve a realistic base case, documented and tested through sensitivity analysis.[5]

When defining the base case, analysts should take care to ensure that:

- important assumptions are clearly documented
- all relevant costs and benefits are included in the base case
- costs are directly related to current policy settings
- evidence is provided for benchmarks, assumptions and forecasts that underpin the base case.

In rare instances where the base case is highly uncertain and difficult to specify, it may be necessary to specify more than one base case.

Level of investment in the base case

Some base cases can be described as a:

- 'spend nothing' scenario: no further investment is expected, e.g., a recurrent program with time limited funding is coming to an end with no legislative requirement or Government commitment to extend or replace it.
- 'do minimum' scenario: there is a commitment to or unavoidable need for some further investment to maintain current service standards, keep services or infrastructure safe and operational, or meet legislated requirements, e.g., replacing unsafe roofing and windows in a building.

Generally, a 'do minimum' level of investment is a **more plausible base case for a wide range of initiatives** than a 'spend nothing' (or 'do nothing') scenario.

Options

CBA should canvass a range of realistic and feasible options. This Guide requires CBA to assess at least two options (in addition to the base case). The challenge is to specify and shortlist a realistic range of options to meet the outcome-based objectives defined in Step 1.

Developing robust, feasible and innovative options often involves a combination of research, evaluations and lessons learned from previous initiatives, expert workshops, and stakeholder engagement. Stakeholder engagement is key to understanding the lived experience and perspectives of people who will be impacted by the initiative.

A broad range of options should be identified at the earliest possible stage of the initiative development process:

- Each option should deliver on the objectives.
- Options may vary in the extent to which they deliver.
- For example, one option could represent a 'minimum viable product' that meets the objectives to the lowest acceptable standard at the lowest feasible cost.

5 For example, Infrastructure Australia's assessment framework states 'the base case should not include investment which is either complementary to or a major substitute for the project being analysed'. (Infrastructure Australia, 2021, Guide to economic appraisal, p19).

- Another option could be designed to meet all objectives at the highest standard.
- Additional options could fit 'in between' these two extremes.

Some examples of options include:

- For capital initiatives: building a new asset, refurbishing existing facilities, postponing or bringing forward an investment, non-build options, demand management to reduce or avoid the capital expenditure, increased maintenance, improvements to resilience or leasing instead of owning an asset.
    - The Guide recommends a non-build option (or options) is assessed at the short list stage wherever practical.
- For recurrent initiatives: service reduction, expansion or redesign, starting delivery of a new service.
- For regulatory initiatives: encouraging or discouraging certain behaviours of households (e.g., cigarette plain packaging) and private businesses (e.g., innovation in point-to-point transport), industry self-regulation, codes of conduct, or information provision.

Options should be carefully specified, including scope, implementation timetable, cross-agency impacts, capital or operational requirements, and key assumptions driving the costs and benefits.

Some useful questions for generating options could include:

- Variations in scale or scope: could the option be smaller or bigger, combined with other programs, provide different service quality or resilience characteristics, use different materials, re-purpose existing assets, have a different design life, or entail a different method of procurement?
- Demand-side measures: could existing services be better rationed using behavioural 'nudges', pricing or eligibility criteria?
- Supply-side measures: could private businesses, workers or markets be incentivised or supported to deliver a solution?
- Site selection: what alternative locations are possible?
- Alternative time paths: could the operation be deferred or undertaken in discrete stages?

Assessing a deferral option is particularly important for options with long-distant benefits.

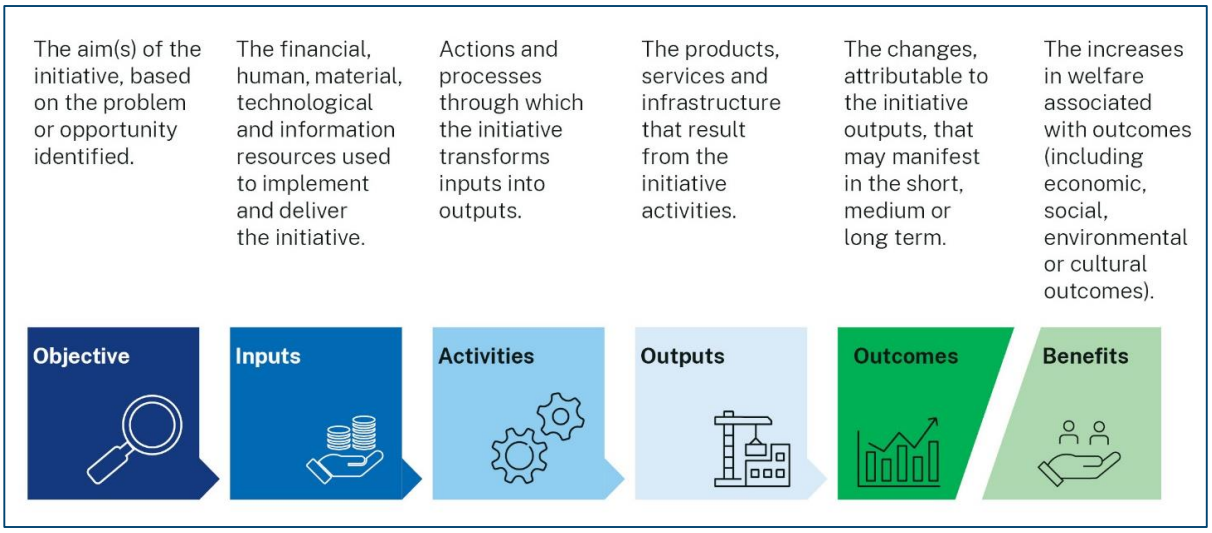
Logic model

Agencies should undertake a logic model analysis as part of the initiative development process (e.g., as a step in the business case process) and **this Guide recommends using the logic model to help build the CBA**.

Logic models describe the links from the initiative's objective to the inputs, activities and outputs it will produce, to the outcomes it is targeting. They provide a robust, logical explanation of how an option will deliver on its objectives.

Logic models can take several forms and are adaptable to the needs of the analysis. Figure 2.2 provides a simple suggested structure. Policy and Guidelines: Evaluation (TPG22-22) provides further guidance on developing a logic model.

Figure 2.2: Typical Logic Model



Options at the different stages of initiative development

The number and nature of options assessed in CBA will vary as the development of an initiative progresses from strategic consideration to an investment decision – starting out very wide and narrowing as analysis is refined. Table 2.2 provides high-level guidance on options development and assessment at each stage.

Table 2.2: Breadth of options at different stages of initiative development

Stage	Options development	Options assessment
Problem definition Business case stage: Problem definition (Stage 0) Options list: unconstrained list or 'very long' list	With clear objectives and problem definition, initiative development can begin with an unconstrained list of all possible solutions. This list should be filtered down to a long list of options to be analysed through CBA in the next stage. This Guide recommends that the unconstrained list of options and the filtering process is documented in the next stage CBA.	Filtering from the unconstrained list to the long list should use a **transparent** and repeatable method of the agency's preference. Agencies may find it valuable to produce a simplified CBA or CEA or use techniques such as multi-criteria analysis or strategic merit tests.
Analysis / development phase Business case stage: Strategic Business Case (SBC) Options list: long list	The long list of options should provide distinct alternatives to meet the objectives. In many cases, this should include some (usually cheaper) option/s that **partially** meets the stated objectives. This Guide suggests the long list for an SBC CBA includes three to six options.	CBA should be used to refine the long list of options down to a short list that will be considered for funding. CBA at this stage may also identify the agency's preferred option, but this preference must be open to genuine review in the DBC. The lower level of detail and rigour in an SBC CBA may mean it:

Stage	Options development	Options assessment
		• does not quantify (but does identify) minor benefit streams • uses costings with a wider margin of error • replaces some finer, unfinished details of options with assumptions.
Investment decision Business case stage: Detailed Business Case (DBC) Options list: short list	The short list of options is made up of refined, well-developed versions of the highest-ranked options from the long list. CBA in a DBC must assess a minimum of two realistic options and is unlikely to assess more than three options. For some DBC, it will be appropriate for the options to be variations on the preferred option from the SBC in scope, scale and timing.	The full short list of options should be subject to a detailed, transparent and rigorous CBA. This is the standard of evidence required to support an investment decision.

Early and genuine partnerships with First Nations communities

Agencies developing CBA for initiatives that have impacts on First Nations communities should work in partnership with them to ensure that:

- impacted First Nations communities understand how the initiative may impact their wellbeing
- legal rights and interests of First Nations people and communities are identified accurately and reflected in the base case, particularly where initiatives have impacts on land use, planning and environment or land ownership
- all potential impacts on First Nations legal rights and interests are reflected in analysis of options — including benefits, costs, and risks.

Where issues are identified, agencies should work in partnership with First Nations communities from the earliest stages of the business case and CBA process, to:

- define opportunities and problems and potential options to respond to them
- understand what First Nations legal rights and interests are impacted
- get input on problem definition and scope of options.

For CBA with land use and land ownership impacts specifically, the value of land for First Nations communities may not be reflected fully in standard metrics (such as land-value uplift or higher-value land use), so there should be significant engagement with First Nations communities to identify the way they may be impacted by an initiative.

Treasury recommends that agencies preparing CBAs for initiatives impacting First Nations people and communities consult the Centre for Evidence and Evaluation and First Nations Economic Wellbeing Branches in Treasury prior to commencing.

Climate risk

The climate in New South Wales has already changed, with extreme weather events becoming more frequent and intense. Climate change can impact on the expected costs and benefits and resilience of an initiative. Impacts can be driven by events (acute shocks), or longer-term shifts (chronic stresses) in climate patterns.

To better enable rigorous decision-making, the risks and impacts of climate change should be incorporated into CBA, where possible.

Initiative options (and base case projections) should appropriately reflect the risks posed by climate change, for example by:

- considering where assets or service demands are affected by climate conditions, or are potentially exposed, or in the future will be exposed, to climate-related natural hazards such as flooding or bushfires
- setting out the extent to which investments are targeted to withstand climate change risks and remain operable and resilient to likely natural hazards
- appropriately valuing options that deliver climate change risk mitigation, for example reducing natural hazard risks
- incorporating carbon emissions impacts and future transition costs into options development.

The Climate Risk Ready NSW Guide provides resources and guidance on understanding, planning for, and adapting to, climate change impacts.

'Real options'

Real options involve making a choice or investment up-front that confers the ability, but not the obligation, to do something in the future. They provide flexibility in response to uncertainty. For example, when building a two-lane road, we could choose to reserve a corridor of land big enough for a four-lane road. This would give us the real option to expand the road to four lanes in the future.

Thinking about real options early in the options development stage can add significant value to CBAs for long-lived or staged initiatives, as well as initiatives exposed to significant uncertainty. Real options are discussed further in Appendix 4.3.[6]

Iteration and Appraisal

Repeated analyses are often needed to develop, refine and short-list options – especially for major expenditure proposals.

Pilot testing an option can be valuable to gather data, test the effectiveness of an initiative and refine option design prior to full roll-out. An option could be selected for a pilot program based on a preliminary analysis, with subsequent wider roll-out informed by evaluation of the pilot and an updated CBA of the full program.

In some cases, approval for an initiative should occur in stages over a long procurement period. The CBA should be progressively updated as options are refined to ensure it still makes sense to proceed.

6 See also published guidance on real options from Australian Transport Assessment and Planning (https://www.atap.gov.au/sites/default/files/documents/atap-t8-real-options-assessment.pdf) and the Victorian Department of Treasury and Finance.

Options for provision on commercial terms

Where an initiative proposes to provide goods or services on commercial terms, the CBA should provide information on the proposed pricing strategy and consider how this will affect costs and benefits (e.g., demand, distribution of costs and benefits). This applies whether the asset will be publicly or privately owned. Treasury's Guidelines for Pricing of User Charges (TPP01-02) provides guidance on setting charges.

2.3 Identify and describe all costs and benefits

After the base case and options are established, the next step is to identify the full range of costs and benefits attributable to each option over the life of the initiative. Recall, CBA captures the *incremental* costs and benefits of an option relative to the base case.

Identifying benefits

Benefits are an increase in welfare associated with an initiative's economic, social, environmental and cultural outcomes. Benefits can be monetary or non-monetary and an initiative's key benefits should flow directly from meeting its objectives.

An increase in welfare means the benefit can be described from the perspective of the beneficiary as a **surplus**. That is, they are getting out more than they put in. For example, if a business spends three dollars making a coffee, including paying the owner the opportunity cost of their time, and sells the coffee for four dollars – the benefit of the sale to that business is one dollar. If the coffee sold for three dollars, there would be no benefit from the business's perspective.

CBA aims to capture all the benefits attributable to an initiative, including non-market benefits such as travel time savings, reduced carbon emissions and environmental amenity. Benefits can generally be included in CBA if they meet each of the following criteria:

- They are attributable to a change **caused** by the option and would not occur in the base case.
- They accrue to NSW households, businesses, governments or non-government organisations (including environmental benefits).
- They are not purely a transfer between NSW parties, i.e., one party loses by the same amount another party gains (see Appendix 3.6 for detailed discussion, including treatment of government grants and vouchers, which should generally be treated as an expenditure)
- There is evidence to support each of these claims.

For practical purposes, the benefits included in CBA should generally also be:

- significant, either in absolute size or impact on a particular group
- measurable.

Agencies should also take care to ensure different benefit categories are not reflecting the same outcome (known as **'double counting'**). For example, one benefit of a software upgrade at a government agency could be time savings for workers completing a routine task. If we then also counted the benefit of the productive activities workers undertake with their new free time, we would be double counting the benefit of the efficiency gain from the software upgrade. In this example, both benefit measures may be valid, but the CBA should only count one of them.

Table 2.3 sets out examples of costs and benefits for some initiative types.

Table 2.3: Examples of costs and benefits in select initiatives

Example	Category	Direct impacts	Indirect impacts
Roads	Costs	Construction costs Maintenance costs	Noise, air pollution and lower amenity around new road
	Benefits	Travel time savings Lower vehicle costs Reduced accidents Reduction in emissions	Savings in travel time, vehicle costs and accidents on other roads
Education	Costs	Cost of delivering education services Student costs: income foregone and out-of-pocket expenses	-
	Benefits	Benefits to students: increased future productivity and earnings	Benefits to employers from higher productivity Reduction in crime and other social costs
Court Infrastructure	Costs	Construction costs Maintenance costs Operating costs	Disruption costs during construction
	Benefits	Reduced court delays Avoided capital, operating and maintenance costs	Placemaking benefits (e.g., urban cooling effect)

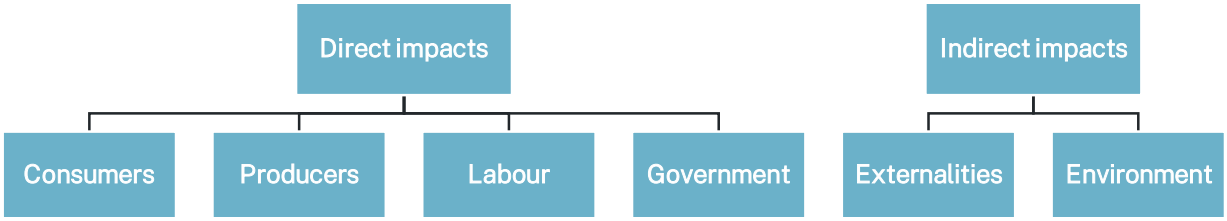
Common benefit categories for regulatory initiatives may include:

- improvements in product and service quality
- improvements in public health and worker safety
- improvements in environmental amenity
- reductions in compliance costs for businesses and administrative costs for government.

Categories of costs and benefits

To help analysts systematically identify costs and benefits, they can be classified as direct or indirect impacts and differentiated by the group impacted (see Figure 2.3).

Figure 2.3: Possible costs and benefits – classifying impacts



Direct and indirect impacts

Direct impacts are primarily impacts on producers (e.g., businesses) and consumers (e.g., households) of goods or services associated with the initiative. Goods and services could be a market good like electricity or a non-market good like a public park, education or healthcare.

Producers, both public (i.e., government businesses) and private, bear the costs of projects or policies. Producers may also obtain benefits from increased output or lower cost inputs that result in changes to profit. Profit is also known as producer surplus in CBA.

For **consumers** (which includes users of free goods or services), **private use values** are usually the most important value. This represents the value that individuals, households, communities or businesses gain from Government services or policy settings. **Private use value is equal to the amount consumers are willing to pay for their own use of the good, service or amenity.**

Consumers may also attribute other values to outcomes, namely option, altruistic or non-use values:

- **Option values** occur when individuals value goods, such as cultural venues, not just for their expected use but also for their possible use.
- **Altruistic values** occur when individuals are willing to pay for someone else's use of a good or service, including use by future generations.
- **Non-use values** occur when people value a good, such as biodiversity, simply for its existence, independently of any use value.

For **workers** (labour), an initiative may impact their employment (e.g., an underutilised worker may have more work opportunities) or result in increased or decreased wages.

For **government**, direct impacts could include savings from avoided costs or revenue gains. Government incurs the resource costs required to provide assets or services to the community. These resources include produced capital (machinery), natural capital (land and ecosystem services) and human capital (labour's know-how).

Indirect impacts are impacts on third parties (households, businesses, non-government organisations or the environment) not directly involved in the consumption or production of the primary good or service. There are two forms of indirect impacts:

- **Externalities:** impacts on third parties as a result of production or consumption, usually in the primary market. For example, power generation may create negative externalities in the form of air pollution and carbon emissions that affect third parties. Initiatives may also impose costs by depleting social (e.g., disruption to existing communities or green space) and cultural capital (e.g., impacting culturally significant sites). Investment in education may create positive externalities by reducing crime and other anti-social behaviour that would affect third parties.
- **Related markets:** impacts on businesses in **complement and substitute markets** of the goods and services involved in the initiative. For example, an initiative that re-stocks a lake with fish for recreational fishers may result in the local fishing supplies store increasing its producer surplus

due to extra demand (complementary market). On the other hand, the nearby golf course may suffer a reduction in demand to play, which reduces their surpluses (substitute market). If prices in the related markets are efficient, then complementary and substitute market effects can be safely ignored, as all else being equal, the primary market will capture all relevant changes to welfare.

Indirect impacts often take the form of **environmental impacts**, for example changes in tree and vegetation cover, waterway health, pollution, soil conditions, carbon emissions, biodiversity, and animal habitats. Environmental impacts may be unintended and not obvious and may reach beyond the physical location of the initiative.

Direct and indirect impacts, where they are relevant, should be forecast and valued as changes relative to the base case.

Multiplier impacts are excluded from CBA

Multiplier impacts (also known as second-round impacts) are the flow-on impacts from increases or decreases in income as they circulate through the economy. For example, if an initiative results in 100 workers' incomes increasing by $10,000, then those workers will spend some of that extra income at businesses. Those businesses might generate extra profits and hire extra workers, and then those workers will spend their extra income at other businesses and so on. This is known as a **multiplier** effect.

Benefits from multiplier impacts are not included in a CBA. Estimates of multiplier impacts are highly variable and contestable and generally do not consider second-round costs. Including multiplier impacts in CBA would also require calculating them for the base case, as the costs of the initiative could otherwise have been spent elsewhere in the economy, where they also would have generated multiplier effects. It would be inaccurate to attribute a multiplier income benefit to the initiative and ignore the possible multiplier benefits of the same expenditure on an alternative project.

Reporting results for alternative referent groups

CBA should include costs and benefits to the NSW community (the referent group). Decision makers may, however, also require local level, cross-border, or national analysis. **Where the CBA includes local or interstate impacts, these should be shown separately from impacts on New South Wales**.

For example, a CBA for coastal management could supplement the results for the overall NSW community with separate analysis of the impacts on the local community. This can help to highlight the **distribution** of costs and benefits within the local area, while also showing the overall results for New South Wales.

CBA with an Australia-wide referent group may also be required for an initiative seeking Commonwealth Government funding (particularly where the Commonwealth Government is seeking initiatives with multi-state impacts). If one business case is being prepared for both NSW Government and the Commonwealth Government, then the CBA results for New South Wales-only and Australia-wide should be reported.

Common benefit categories

Table 2.4: Common benefit categories

Item	Description
B1. Savings or avoided costs	Expected reductions in public or private expenditure due to an initiative.

Item	Description
	This could be due to improved efficiency or reduced need for future services (e.g., an early intervention program reducing the future need for acute health, education, community or justice services).
B2. Government revenue	Incremental extra revenue to the NSW Government resulting from the initiative that would not be realised in the base case. Generally included only when extra revenue is raised from non-NSW parties, as fees or taxes paid by NSW residents would be a transfer (from the payer to the Government) rather than a cost or benefit.
B3. Consumer surplus	When a consumer receives a good or service at a lower price than the maximum they are willing to pay. Initiatives that improve a service may increase consumer surplus. For example, travel time savings, improved green or public space, improved theatre or museum offerings.
B4. Producer surplus	When the price that a producer receives for a good or service is greater than the cost of production.
B5. Labour surplus	When a worker's actual wages are greater than the minimum they are willing to accept to do the job (i.e., their reservation wage).
B6. Benefits to the broader community	The benefits of public services, such as emergency services, health and education services, and public transport, that flow to the community as a whole rather than to the users of the services only. For example, public transport can generate lower pollution and reduced congestion. These benefits accruing to third parties are known as positive externalities. Note: when a price is charged for a public service, but that price does not reflect the full value of positive externalities, the price alone will not reflect the full benefits of the service.
B7. Residual value	When an asset still has value at the end of the CBA analysis period. This could be because the asset is still producing benefits or because it can be resold.

Some initiatives aim to improve the resilience of a system to the impacts of adverse events (e.g., improved ability of infrastructure to operate following a natural disaster) or reduce the risk of an adverse event occurring or both. The benefits stemming from these outcomes can often be categorised according to Table 2.4.

Note, an initiative may cause both positive and negative changes in the benefit categories in Table 2.4. For example, an adjustment to a bus route may improve the travel experience (increase consumer surplus) for most bus users but be less convenient (reduce consumer surplus) for a few. In such cases, CBA measures the **net change** in benefits from the initiative.

Common cost categories

Table 2.5: Common cost categories

Item	Description
C1. Capital costs	Examples include: • capital costs of new assets • capital costs of asset replacements • major periodic maintenance or refurbishment costs.
C2. Recurrent costs	Examples include: • agency salaries or wages and labour on-costs • accommodation expenses • operating and maintenance costs, including subcontracted external labour or rented capital.
C3. Regulatory costs	Examples of possible costs of regulatory proposals include: • administrative and compliance costs for regulated entities • cost to government agencies in administering the regulation • reduced consumer surplus from restrictions on competition or choice • restrictions on innovation that reduce potential consumer surplus • delays that impose holding costs on businesses.
C4. Ancillary	Examples of ancillary costs include: • transaction costs • costs of remediation • relocation, temporary accommodation and other disruption costs. For example, disruption to businesses during construction.
C5. Costs to the broader community	Third party costs on the community or groups within it. Examples of third party costs, known as negative externalities, include noise, congestion, pollution, carbon emissions and reduction in visual amenity.

2.4 Forecast all quantifiable costs and benefits

The next step in estimating costs and benefits is forecasting the volume or quantity of outcomes, for example:

- number of additional passenger trips on a bus route
- number of tenants moved from the waitlist into social housing
- average increase in student test scores
- decrease in probability of developing diabetes.

Volume or quantity of outcomes can be forecast using a variety of techniques and approaches depending on the data available and the unique characteristics of the proposal. See Appendix 1 for further discussion on forecasting methods and issues.

For example, estimates of costs for infrastructure projects require forecasts of the scope and schedule of works and quantities of land, labour and materials required. These estimates are often sensitive to project design and technology, which may change as the project matures, and in-ground conditions.

Costs and benefits often accrue at different times over the life of an initiative. Forecasts should consider when costs and benefits start, finish, peak and/or trail off and whether there is expected to be a 'ramping up' period (e.g., where a benefit starts out small as users learn about a new service and picks up to its full level after a few years).

Forecasts should also consider the potential for changing external circumstances to impact outcomes, both for the base case and options. For example:

- Climate change and increased frequency of extreme weather events may impact the effectiveness, resilience and maintenance needs of infrastructure.
- The unanticipated acceleration in working from home due to the COVID-19 pandemic may affect travel patterns and subsequent demand for transport options.

Approach to forecasting

Predicting the future is unavoidably challenging — especially for novel initiatives. Ideally, analysts can draw on evaluation of previous, similar initiatives. Where this is not possible, analysts need to use their judgement to build a forecast from a combination of:

- *ex post* evaluation on the impacts of somewhat comparable initiatives
- relevant and valid literature estimating effect sizes
- parameters and approaches used and validated in previous *ex ante* CBA
- generic economic parameters such as elasticities or growth rates, and
- expert opinion (published opinions or experts consulted for the initiative).

In all cases, transparency is key. Analysts should make their assumptions and uncertainties transparent, both in presentation and when applying methods to account for uncertainty.

Additional technical expertise may be required to forecast outcomes and behaviour changes, for example, a potential reduction in water quality or number of trips on a toll road. This work is often undertaken by specialist subject matter experts and should be subject to **independent peer review** given the specialist nature of this work and the significant scope for weak assumptions or errors.

Peer review can also help counter optimism bias, an important consideration discussed in Box 2.2.[7]

Box 2.2: Optimism bias

Optimism bias is a cognitive bias that results in people systematically underestimating the likelihood of negative events occurring. Planning fallacy is a related bias that results in over-optimistic projections of how smoothly a planned project will run.

In CBA, optimism bias can result in overstating benefits and understating costs, overly optimistic demand projections or underestimation of the impact or likelihood of downside risks. Empirical research suggests unchecked optimism bias can have a significant impact on the reliability of CBA estimates.

Recommended steps to address optimism bias include:

- soliciting an 'outside view' of the analysis, for example through independent peer review
- undertaking sensitivity analysis on a realistic 'worst-case scenario' with lower benefits and higher costs
- where data is available, adjusting forecasts based on the forecast errors of past initiatives (this technique is known as reference class forecasting discussed further in Appendix 1).

Forecasting is often undertaken in a spreadsheet setting out the data inputs, assumptions, methodology and outputs (potentially including charts, tables and other figures). It is essential the model apply good practice to be transparent and able to be reviewed. A copy of the forecasting spreadsheet model should accompany the CBA report for reviewers.

Qualitative costs and benefits

Quantified costs and benefits are a key output of CBA, but in some cases quantification may not be practical. **Impacts that cannot be quantified should still be accounted for qualitatively**. A list of significant qualitative factors should be recorded in the CBA to inform decision makers, including the direction of the impacts and their likely significance.

Analysis period

The analysis period defines the start and end date of a CBA. **It should be long enough to capture all significant costs and benefits of the initiative**. Generally, this means the analysis period should match the expected economic life or design life of the initiative.

The analysis period should begin in the first year that funds are expended on implementing the initiative (or the first year regulation comes into force). Note, costs and benefits in the very first year of the analysis period are not discounted. The first few years of the analysis period for many options will cover an implementation, delivery or construction period before the initiative is operational.

7 See, for example, Flyvbjerg Band Bester DW (2021) 'The cost-benefit fallacy: why cost-benefit analysis is broken and how to fix it', *Journal of Benefit-Cost Analysis*, 1-25.

If the benefits or costs are expected to persist after the initiative has ceased operating, then the analysis period should be appropriately extended.[8] **The Guide suggests possible analysis periods** in Table 2.6, but these are not mandatory.

As the analysis period gets longer, forecasting becomes more uncertain. Extending the analysis period past 60 years is only likely to be valuable if one of the **primary** benefit categories cannot otherwise be captured. For example, it may make sense for initiatives primarily concerned with very long-term outcomes, such as climate change, to use analysis periods of 60 to 100 years.

Table 2.6: Suggested analysis periods by initiative type

Type	Suggested analysis period
Capital	• **30-60 years** post-construction for most capital infrastructure types. • For assets with a long life, a residual value may need to be calculated (see Appendix 3.1).
Recurrent	• Match analysis period to the life of the initiative or the duration for which funding is requested. • Often **1-20 years** based on known ends dates including associated funding commitments.
ICT	• Often **2-5 years** and likely no longer than 10 years considering the short product lifecycle in ICT.
Regulation	• Long enough to capture all incremental impacts depending on the nature of the regulation. • Often **5-20 years**, depending on the nature of the regulation and how long it is likely to remain in force until reviewed.

2.5 Value quantified costs and benefits

The starting point for valuation is establishing a standard unit of measure. Valuation in CBA uses Australian dollars in real terms (i.e., excluding inflation). This is also known as constant dollar terms.

Willingness to pay

The core valuation principle is that goods, services and non-market outcomes are valued at the dollar amounts that individuals or businesses are willing to pay for them.

The preferences of individuals and businesses are the primary indicators for valuations. CBA valuations aim to estimate how much value people place on a given outcome relative to other outcomes. For non-market outcomes, CBA does this by estimating the dollar amounts that the relevant parties would be willing to pay for the outcome in a hypothetical world where it was for sale.

8 Benefit streams that accrue for many years after an initiative ends (e.g., future lifetime earnings uplift for school students or long-term health benefits from prevention) can be summed up and discounted to a present value using the central discount rate and included as a lump sum in the final year of the analysis period. The lump sum will then be discounted back to the start year in the final NPV and BCR. This can avoid the need for extremely long analysis periods while achieving the same results.

The underlying assumption is if we're willing to give up more of our income for Outcome A than for Outcome B, then we gain more benefit from Outcome A. While these valuations are not a precise science, they represent a consistent and highly adaptable methodology with sound theoretical underpinnings.

Opportunity cost

The costs of resources in CBA are based on the principle of opportunity cost. In a competitive market, market prices reflect the value of resources in alternative uses. Most markets for goods and services in New South Wales are largely competitive and, as a result, market prices tend to reflect the value of resources used in production.

Generally, CBA should use market prices to value the resources procured by Government as inputs to an initiative (like labour and materials). There may be situations, however, where market prices need to be adjusted for taxes or subsidies, regulated prices or lack of competition.

Non-market valuations

Applying the valuation principles of willingness to pay and opportunity cost is challenging when market prices are poor indicators of value – especially for goods and services that aren't bought and sold in a market (non-market goods).

For outcomes that do not have a clear market price, there is a range of alternative approaches that can support valuations (see Appendix 2 for further discussion and guidance), such as:

- Revealed preference: valuing the non-monetary resources people actually expend to achieve an outcome.
- Stated preference: using survey data to elicit willingness-to-pay estimates directly from consumers or stakeholders.
- Linking a difficult-to-value outcome to another outcome that can be valued: e.g., a student completing Year 12 can be linked to that student earning a higher income later in life.
- Avoided costs to Government: some outcomes reduce the future need for Government to provide support services, e.g., improved mental health outcomes may reduce the later need to access health services or interact with the justice system.
- Replacement costs: e.g., avoided flood damage.
- Well established proxy measures: e.g., quality adjusted life year (QALY), travel time savings.
- Hedonic analysis: e.g., discerning the value of green space by measuring uplift in nearby property prices (a form of revealed preference).

Valuations in practice

Costs and benefits that do not receive a valuation (that is, have their value expressed in dollars) cannot be included in the BCR and NPV results. Decision-makers should be encouraged to consider the impacts of unquantified costs and benefits where their existence is well-supported by evidence, and they are sufficiently large to influence the decision.

Nonetheless, accounting for costs and benefits in quantitative CBA results (BCR and NPV) facilitates consistent and efficient resource allocation decisions and **this Guide recommends valuing all significant costs and benefits whenever possible** (see Box 2.3). Table 2.7 discusses approaches to valuation under different circumstances.

Box 2.3: Evidence to support valuation

All significant benefits should be valued, provided they can be attributed to the initiative and the forecast quantities are supported by reasonably robust evidence. The valuation step is critical to produce numerical CBA results.

Valuations should be based on the **best evidence available**, with the effort devoted to collecting evidence proportional to the significance of the cost or benefit stream. In many cases, valuation evidence for non-market benefits will not be definitive and analysts will have to use judgement to reach a transparent and defensible conclusion. A reasonable 'margin of error' around this valuation should then be tested in sensitivity analysis.

This Guide recommends expressing the value of costs and benefits in dollars even where evidence to support the valuation is non-definitive, as long as:

- thorough literature review has been undertaken to support the best benefit transfer possible
- parameters and findings from literature have been used accurately and appropriately, and
- the CBA clearly communicates key risks and uncertainties in the final results stemming from valuation challenges.

Table 2.7: Approaches to valuation in different circumstances

Type of valuation	Examples	Treatment
Quantity (volume) estimate, and unit prices are available	• Additional electricity supplies to users. • Capital expenditure. • Operating costs.	All major costs and benefits should be included quantitatively in CBA result.
Quantity can be estimated, but hard to value in monetary terms	• Museum visits. • More play space in a school. • Easier access to green space. • Carbon emissions.	Minor costs or benefits can be described qualitatively. Significant costs and benefits will require analysts to draw broadly on the best evidence and methodologies available to produce a transparent, defensible valuation. Sector-specific CBA frameworks and valuation databases can be an important source of 'standardised' valuation parameters. Further detail on treatment of carbon emissions is provided in Appendix 3.
Quantity cannot be precisely estimated **and**	• Aesthetic effects of	Minor costs or benefits can be described qualitatively.

Type of valuation	Examples	Treatment
hard to value in monetary terms	beautification programs. • Community pride. • Increased research and development.	Significant costs and benefits may warrant primary research (e.g., conducting surveys) or development of methods to quantify and value. Sensitivity analysis on these estimates and valuations will be critical. Note: costs that cannot be valued are just as important as benefits that cannot be valued and should be accorded equal treatment.

Escalation

CBA uses real values for cost and benefit streams, that is, inflation is excluded. The real prices of specific items might, however, be expected to change over the analysis period of a CBA. That is, some prices may be projected to increase significantly faster or slower than general inflation, for example land or housing. In such cases, the expected real price changes should be reflected in the cost and benefit streams and the CBA should document the assumptions used.

Generally, the default assumption will be no real escalation in the central estimate, but this can be challenged if there is supporting evidence from market indicators, market sounding, literature or empirical studies to expect real changes in prices over the long-term.

Costings

This Guide recommends that, where possible, costings based on expected value (i.e., average value) are used to determine costs in CBA for the central estimate.

Costings used in CBA should become more accurate as it gets closer to the investment decision (e.g., detailed business cases should have more rigorous costings than strategic business cases). For early-stage investigations, the amount spent on developing cost estimates should be enough to support an informed choice, rather than being definitive.

Infrastructure NSW's *Cost Control Framework for the Infrastructure Program* provides a consistent approach to developing cost estimates for infrastructure initiatives.

Some initiatives produce cost estimates at the median level (also called 'P50'). Analysts should be wary of uneven, 'fat-tailed' or skewed cost distributions that can result in median cost varying significantly from the expected value (i.e., average cost).

2.6 Assess net benefit (NPV and BCR) with sensitivity analysis

Present values

CBA compares the **present values** of cost and benefit streams to allow for costs and benefits occurring at different times. This is calculated by discounting values in future years back to the present year using a central real social discount rate of 5 per cent. Appendix 6 provides further information on social discount rates.

Discounting reflects the view that a dollar received now can be invested to generate further returns, and so is worth more than a dollar received in the future. Using present values in CBA allows decisions to be made in the present about initiatives that have costs and benefits in the future.

CBA results

The aim of CBA is to summarise the full impacts of an initiative. To achieve this, costs and benefits for all entities (households, firms, governments and non-government organisations, including environmental impacts) within the NSW community are aggregated into an overall measure of net social benefit.

In the CBA report, the following measures are **required** to be calculated for each option relative to the base case:

- **Benefit-cost Ratio (BCR)** – The ratio of the present value of net benefits to the present value of resource costs.
- **Net Present Value (NPV)** – The difference between the present value of benefits and the present value of costs.

The NPV and BCR both show, for a given discount rate, whether the quantified benefits are expected to exceed the quantified costs of an option. An option is expected to deliver a net increase in social welfare if the NPV is positive and the BCR is greater than 1.

Appendix 7 provides further detail about the NPV and BCR, including how to use the results to rank different initiatives.

The central estimate

The central estimate of BCR and NPV is defined as the estimate produced using:

- the central real social discount rate set in this Guide (5 per cent)
- NSW referent group
- the agency's central estimates of costs and benefits. This should generally be the expected (average) values, but in some cases may be the most likely outcome, a conservative estimate, the median value or a midpoint or average of several estimates,
- quantified costs or benefits that are particularly difficult to estimate or attribute with confidence may be left out of the central estimate and instead included as 'upside' or 'downside' sensitivities.

Sensitivity Analysis

CBAs are required to include sensitivity analysis that shows the impact on the BCR and NPV of each option when assumptions or parameters are adjusted, to plausible alternative values, to reflect key risks and uncertainties. Examples of sensitivity analyses include:

- Risks: low and high estimates of population growth or infrastructure usage.
- Assumptions: slow and fast uptake of a new service.
- Parameters: low and high estimates from the willingness-to-pay survey informing a benefit valuation.
- Discount rate: sensitivity test at 3 and 7 per cent (required).
- Climate change: low, medium and high warming scenarios.

The purpose of sensitivity analysis is to assess the robustness of the initiative to plausible variations from the central estimate. For example, one option might produce the highest NPV and BCR under the central set of assumptions but poor results under other plausible assumptions, while another option produces satisfactory results under all sets of assumptions.

Where there is a trade-off between possible higher net benefits and higher risk or uncertainty, sensitivity analysis allows for informed decision-making on how much risk to accept.

Sensitivity analysis should be informed by key risks identified and how these affect the key outcomes of the proposal. This should include identifying key dependencies between different elements of an initiative to help construct realistic upside and downside scenarios.

Where key variables may be correlated, sensitivity analysis can be run on **multiple variables moving at the same time**, e.g., a worst- or best-case scenario.

Sensitivity analysis should also consider which assumptions and parameters are subject to the greatest degree of uncertainty. The greater the uncertainty, the wider the range of outcomes that should be tested in a sensitivity analysis.

Finally, **probabilistic modelling analysis**, using techniques such as Monte Carlo analysis, can provide strong insight into complex or interrelated risks. Where data on the possible distribution of a variable exists or can be inferred, Monte Carlo analysis, for example, can be an accessible and useful tool.

Appendix 4.2 provides further practical guidance on conducting sensitivity analysis.

Risk identification

Risks should be identified, planned for, and managed, with the goal of reducing or mitigating risks where possible. CBA should consider the impact and likelihood of residual risk – that is, the risks that remain after management and mitigation measures.

The degree of detail in identifying and assessing risks will depend on the nature of the initiative, including the variety of stakeholders involved. For example, smaller-scale initiatives may require testing against a sufficient contingency allowance, based on costs incurred in previous similar initiatives. At the other extreme, large complex projects may require significant investment in legal, commercial or technical engineering work to identify and value risks and provide adequate risk mitigation strategies.

2.7 Assess distributional and equity impacts

The distribution of gains and losses can be an important aspect of a new initiative, particularly in a reform context. The success of an initiative may hinge on a robust understanding of the distributional impacts, as well as appropriate strategies to manage the distribution of gains and losses.

This Guide requires that distributional analysis is included as supplementary information in a CBA. Distributional analysis may be qualitative or ideally supported by quantitative findings where data allows.

Box 2.4 provides an example of how distributional analysis can help to promote equity by highlighting gains and losses. Appendix 5 provides further information, including templates.

Box 2.4: Distributional impacts

An initiative to introduce a road-pricing regime could reduce congestion on the roads network. Given the varying travel requirements of different groups of households and businesses, the benefits and costs of a road pricing regime may not, however, be evenly distributed.

Although most road users would benefit from faster travel times, households with less flexible travel requirements might incur greater costs. These distributional impacts, even though they are transfers from one NSW party to another, can be usefully highlighted in CBA. Even if the project has a net social benefit, the costs imposed on low-income groups may highlight the need for mechanisms that manage the distribution of gains and losses more equitably (such as concessions).

Analysis of impacts by stakeholder groups (e.g., income bands) can help with assessment of distributional impacts. Any data limitations should be outlined.

Note that transfers between groups, which are highlighted in distributional analysis, need to be accounted for (i.e., netted off **or** excluded if both groups are NSW residents, see Appendix 3.6) in calculating the overall NPV and BCR to avoid double-counting.

2.8 Report results and key findings in executive summary format

A CBA report should include an executive summary with the following key information:

- Central estimate of Net Present Value (NPV) and Benefit Cost Ratio (BCR) for each option relative to the base case, at the central real social discount rate (5 per cent).
- NPV and BCR results for each option in key sensitivity analysis, including the 'high' and 'low' discount rate sensitivities set in the Guide (7 and 3 per cent, respectively).
- A clear and concise summary of the:
    - **objectives of the initiative**
    - **base case**, and
    - **options assessed** (focusing on major differences between the options).
- A summary table showing **key categories of benefits and costs** and the dollar values and percentage contribution of each to total benefits or costs in each option, relative to the base case.
- Significant costs and benefits that could not be quantified and their expected impact
- All **critical assumptions**, supported by evidence. This includes key drivers, inputs, risks and assumptions used in constructing the base case and options.
- Examples of key assumptions include demand growth and its components (e.g., population growth or changes in usage of the service),
- Report which option performs the strongest in CBA. That is, the option with the highest central NPV and BCR (Appendix 7 provides guidance on situations where the highest NPV and BCR do

not align).[9] Agencies may view an alternative option as the strongest performer in the CBA if there are compelling indications that:

  - critical costs or benefits that would influence the ranking of options could not be quantified, or
  - an option with a lower central NPV and BCR is more robust to key risks and uncertainties, as shown by stronger results in sensitivity analyses.

- If required, a separate presentation of NPV and BCR for each option with an alternate referent group. That is, a local referent group or a whole-of-Australia referent group.

2.9 Establish evaluation and monitoring plan

The TPG22-22 Policy and Guidelines: Evaluation establishes that **initiatives resourced by the NSW Government must be regularly examined** to ensure they are achieving their intended outcomes and providing a net social benefit to the people of New South Wales.

CBA is the preferred approach for *ex post* economic evaluation. When effectively designed and implemented, *ex post* CBA can provide more accurate estimates than *ex ante* CBA. *Ex post* CBA results and insights can then build the evidence base for future *ex ante* CBA.

Planning for monitoring and evaluation

It is critical for effective evaluation that agencies develop monitoring and evaluation plans early in the initiative design (well before implementation), including allocating funding to monitoring and evaluation.

Monitoring can be designed to track and report on initiative performance and inform ongoing improvement, and to collect information that will support evaluation. Evaluation should be scheduled as relevant to the key stages of initiative implementation and outcomes and benefits realisation, and the evidence required to inform decision-making.

The *NSW Benefits Realisation Management Framework* provides best practice principles for agencies in identifying, planning, managing, reporting and evaluating benefits. It also ensures that business areas are committed to realising benefits.

2.10 Further assistance

Agencies are encouraged to contact their Treasury analysts early to work through any issues or queries. CBA related queries can also be sent to cee@treasury.nsw.gov.au.

9 If all options have a negative NPV and BCR below one, then the base case is the strongest performer.

Appendix 1: Forecasting

This appendix discusses practical forecasting issues and common methods, including:

- Overview of forecasting
- Best attempt forecasting
- Evidence and forecasting

A1.1 Overview of forecasting

Forecasting outcomes is a key component of all CBAs and helps inform cost and benefit estimates. The aim of forecasting is to predict the **quantity or volume** of outcomes over the life of the initiative. This includes predicting the quantity or volume in the base case and the quantity or volume for each of the options evaluated. Together, this gives the change in outcome due to the initiative, e.g., change in passenger trips (outcome) from a public transport investment (initiative) that will benefit users or impose costs (impact).

Forecasting can be a challenging process as predicting future outcomes is inherently uncertain. In the face of such uncertainty, forecasts may rely on reasonable assumptions. Where forecasts depend on assumptions, the assumptions should be made explicit, and the sensitivity of outcomes should be tested and reported. **Assumptions should be guided by research and evidence**.

Analysts are encouraged to engage with Treasury as early as possible on forecasting challenges for complex initiatives, particularly if there are issues with quantifying outcomes or the cost of forecasting is considered excessive relative to the size of the project.

Some known forecasting challenges are listed in Box A1.1. Potential methods to counter these challenges include statistical or econometric analysis, relevant expert advice, and probabilistic assessment. In the end, **forecasts are the best unbiased estimates based on the methods and information available to analysts.**

Box A1.1: Practical challenges to consider when forecasting

- Technological development, for example in communications technology or renewable energy.
- Attributing probability to events, in particular very low occurrence events (e.g., 1 in 1,000-year events) such as floods, that may be less predictable.
- Attribution concerns: accounting for other possible causes of outcomes (omitted variables).
- Changes in behaviour due to the initiative and its effects over time.
- Past events and behaviours may have limited applicability to new policies aiming to change current patterns of behaviour and social values.
- Complex and nonlinear systems, such as traffic modelling across a large transport network.
- Historical growth rates of key variables based on limited observations or an inappropriate reference group.
- Non-market outcomes that are not easily observable. Using proxies or functions to forecast values can introduce estimation errors.

Box A1.1 continued: Practical challenges to consider when forecasting

- Complex interactions between ecological systems, for example, quality of groundwater and production functions for crop yields.
- Unexpected changes in taste and preferences, e.g., shifts towards working from home.

A1.2 Best attempt forecasting

Estimating costs and benefits depends on assumptions made about quantity (or volume) on the one hand and unit costs or unit prices on the other. When a demand curve is available or can be estimated, then forecasting and valuation can be done together. Frequently this is not the case and forecasting and valuation (discussed in Appendix 2) are separate exercises.

Forecasting is challenging and more distant forecasts will be increasingly uncertain. A CBA should be undertaken on best attempt forecasting by using the best available data and methods to forecast how the proposed initiative affects outcomes that benefit the NSW community.

Best attempt forecasting should be supported by evidence and clearly catalogued in the CBA analysis to ensure the data used and assumptions made in this process can be reviewed.

Breaking forecasts into logical parts

Forecasting attempts to obtain a plausible set of outcomes for identified benefits and costs over time. These outcomes are intended to show the 'cause and effect' or 'attribution' from an initiative. Forecasts can be undertaken for each option, the base case or to show the incremental change in outcome, such as forecasting that the base case occurs implicitly.

A useful way to approach forecasting is to break down the task into separate, manageable components. A simple list is discussed below in relation to demand:

1. **Identify the scope of the outcomes to be predicted**: Identify the 'cause and effect' in the primary market or activity following the introduction of the initiative and the extent to which the initiative will change behaviour. This should also be undertaken for third-party outcomes.
2. **Study area:** Identify the location that accounts for demand for the good or service by those within the referent group. The study area should be sufficient to account for all main direct users and any significant indirectly affected parties.
3. **Who will use the goods or service provided:** There may be various groups of users that may use the good or service provided by the initiative. Identifying the user group can help analysts to understand the potential number of individuals or businesses the initiative affects. Combined with the level of use, total demand can be estimated.
4. **Level of use by identified users:** Level of use relates to the *volume* of the good or service demanded by each user following the initiative. While a good or a service may be available, this does not mean the identified users will access it to the same level.
5. **Additional factors to consider:**
    a. Growth rates: How will the number of users and level of usage change over the life of the initiative, e.g., is the number for each constant increasing or decreasing, will there be a ramp-up period before stabilising? Is it reasonable to assume that use will grow with the general

population, or should it be liked to a specific cohort (e.g., school aged children). Are growth rates borne out in *ex-post* evaluations?

b. Clarify the timing and longevity of outcomes: Responses to some changes, such as price increases or take-up of a new service, tend to grow over time as firms and households adjust their behaviour. In contrast, responses to other changes, such as advertising campaigns, may decline over time.

c. Distinguish between stocks and flows: Is the good or service demanded for a single point in time (stock) or is it continuously available for users (flow)? Forecasting will differ for stocks and flows and analysts should ensure they are applying the correct inputs.

6. **Scoping the initiative to inform demand:** A key process for forecasting is to ensure the initiative's outputs are well scoped out to inform design and delivery, which ultimately affects use and costs. If the initiative's outputs are unclear, then this flows through to forecasts of demand. Professional advice may be needed to design the initiative, but to ensure this advice delivers on intended objectives it requires clarity when scoping potential solutions.
7. **Capacity:** When forecasting the outcomes of the initiative, consideration should be given to the capacity of the overall market, and the extent to which the market can absorb additional supply from the initiative, which may vary depending on the option being considered. That is, for some options there may not be sufficient demand to absorb the change in capacity or supply created (e.g., providing to a domestic market), others may have significant capacity (e.g., providing into an international market).

These steps can also be applied to forecast the base case without the initiative to ensure only incremental changes are counted. Forecasting the base case first identifies the scale of the problem or opportunity. This would start with identifying the situation today and then projecting this into the future. That is, current travel times, procedure waiting lists, intersection performance or flood damages. Then identify the drivers of this situation and how these drivers will change to forecast the base case outcomes.

Sources of evidence for forecasting

There are many ways to forecast an outcome. Each type of forecast will require different types of data, knowledge, and expertise. They can also be undertaken using statistical or econometric methods, e.g., time series or cross-sectional analysis or other modelling approaches. Forecasts can be informed by qualitative methods such as expert opinion and some types of survey responses. Some of the sources of data are discussed below.

Meta-analysis draws on a pool of published studies to obtain estimates on mean impacts and variations. For those conducting a meta-analysis, it first requires a methodical, documented search for studies (taking care to avoid confirmation bias in searches), careful filtering to find comparable studies, and a standardised measure of effect so that the findings can be compared.

Simple meta-analyses find an average effect size and variance. More detailed studies use multivariate regression analysis to estimate an average effect size and variance controlling for quality of study, variations in the study populations, and other details in study implementation.[10]

Meta-analysis reduces the bias that can result from reliance on a single study (if there are robust criteria for inclusion of studies). However, when applying meta-analysis results to an initiative, it is still important to consider differences between socio-economic conditions in the research studies and the initiative's target cohort. In some cases, it may be appropriate to adjust results to account

10 For example, see Washington State Institute for Public Policy https://www.wsipp.wa.gov/Publications

for these differences, but these adjustments are complex, and likely require independent peer review.

Simulation models provide projections based on evidence collected and analysed over many years. Examples include computable general equilibrium (CGE) models, transport models,[11] climate change modelling, energy (electricity) demand and hydrological (water supply, or flood) modelling. Only CGE modelling is described in detail in the CBA Guide given its relationship to partial equilibrium which underpins CBA. CGE models show how an economy may respond to changes in policy, technology, or other exogenous factors, e.g., to forecast the impacts of tax policy, trade policy, climate change and changes in international prices on an economy (see Appendix 8).

Market research in the form of focus groups or other surveys are widely used to forecast consumer demand in the private sector. It can also be used to forecast how people will respond to changes in public programs or policies. For example, before requiring packaging of tobacco products to depict various forms of serious diseases in 2005, the Commonwealth Government commissioned extensive focus group research to determine whether tobacco smokers would change their smoking behaviour because of such pictures.

Choice modelling is a form of marketing research that has become more widely used in CBA to obtain estimates of consumer choices and surplus. It attempts to model the decision process of an individual via stated preference methods made in a particular context. For example, when constructing a cultural venue, choice modelling can be used to measure public reaction to choices of location, opening hours, contents, and other factors. Choice modelling provides a method for understanding and forecasting the trade-off decisions individuals are likely to make.

The choice of forecasting technique may depend on the available evidence or data. In other cases, it may be possible to use multiple sources of data or methods of forecasting to provide a well-rounded forecast to use in the CBA, known as 'triangulation'.[12]

Reference Class Forecasting

Analysts should consider ways to minimise the potential for optimism bias in projects. An established method to address optimism bias entering in forecasts is reference class forecasting (RCF).[13]

RCF uses actual data on outcomes from a group of past, similar initiatives (the reference class) to inform forecasting of the current initiative's outcomes.[14] For example, if we are producing a CBA for a new bridge, our forecasts could be informed by data on actual outcomes versus forecast outcomes for cost, schedule, and usage of the last five similar bridges built in Australia.

RCF takes an outside perspective to forecasting by basing estimates on the actual past performance of other initiatives relative to forecasts. This contrasts with an inside view, where a project team bases forecasts on their own views about the specific features of their initiative.

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11 See Transport for NSW – Cost-Benefit Analysis Guide, Section 4.1.6 for more information.

12 Triangulation takes multiple studies or data sources investigating the same (or similar) subject and assists to improve the credibility of findings or explain unexpected findings. It is good practice to triangulate transferred estimates across different studies, where possible. When multiple sources of reasonable quality exist, triangulation can offset limitations and biases that can arise from using a single source. Triangulation can be applied to data sources, theory, investigator and methods as identified in Denzin NK (1978) 'Triangulation: a case for methodological evaluation and combination', *Sociological Methods*, 339-357.

13 Studies can account for optimism bias by adjusting based on prior over or underestimations, see Salling KB and Leleur S (2017) 'Transport project evaluation: feasibility risk assessment and scenario forecasting', *Transport*, 32(2):180-191.

14 Flyvbjerg and Bent, (2008) 'Curbing optimism bias and strategic misrepresentation in planning: reference class forecasting in practice' *European Planning Studies*, 16(1): 3-21.

The reference class used should be similar to the proposed initiative. Note, RCF provides a best estimate based on the average of the reference class. The initiative may perform better or worse than the reference class and RCF does not account for unknown, material differences between the initiative and the reference class.

RCF is carried out in three steps:

1. Identify the reference class, that is a plausible and comparable set of previous projects that is broad enough (to be statistically significant) but still relevant to the initiative.
2. Establish a probability distribution for the reference class, which will depend on quality data across a reasonable number of projects. For example, the probability distribution of cost over-runs relative to business case estimates.
3. Compare the proposed initiative with the reference class to establish its outcome within the distribution.

RCF is also useful in dealing with quantifiable risks by placing the forecast within a reference class of previous similar projects that may have faced similar risks (with similar probabilities of occurring).

A1.3 Evidence and forecasting

Evidence used to inform forecasting can come in multiple forms from multiple sources. The assessment of evidence should be informed by two governing aspects:

- **Relevance**: how closely connected or related the evidence is to the policy initiative.
- **Validity**: relates to causality, i.e., the appropriateness of the method used to assess the attribution of the initiative, i.e., the measured difference to the base case.

Evidence hierarchies may be considered by analysts as useful in assessing how evidence compares against other sources. Hierarchies can convey the sense that there is a consistent set order of evidence which is preferred for CBAs. However, this is not always the case and hence evidence selection should rely on relevance and validity.

Treasury remains agnostic as to the source of evidence used to forecast. All else being equal, studies may be preferred if they are published in high-quality journals, if they use Australian data, if they are published more recently, and if they are more similar to the initiative under consideration.

Evidence used to support forecasting

There are three main types of evidence to support forecasting:

- experimental studies
- quasi-experimental studies
- non-experimental studies.

Ex post evaluation of the same initiative in New South Wales provides the most relevant source of evidence for *ex ante* CBA of the same or similar initiatives, see the NSW Government Guide to Evaluation (TPG22-22). They can provide both the relevance and validity required for future investment decisions on the same or closely related initiative. Therefore, emphasis should be given both to undertaking and sourcing data from *ex-post* evaluations.

Experimental studies

Experimental studies randomly assign participants into a treatment group that receives the intervention being studied and a control group that does not receive the intervention. With an

appropriate sample size, randomisation means that any differences in outcomes between the treatment group and control group are likely to have been caused by the intervention.

Quasi-experimental studies

Quasi-experimental studies, also known as non-randomised experimental studies, lack random assignment of participants to a treatment or control group.[15] Instead, the subjects of the study are assigned to the treatment through some non-random criteria, like geography or eligibility cut-offs.

Non-experimental studies

Empirical work in the social sciences is often based on natural data. That is, data on things occurring in the world (without the intervention of a researcher, as distinct from experimental data). Natural data may consist of time series, cross-sectional data, or a combination of each and may be obtained via regular or one-off surveys. This data also includes official projections of important drivers such as, but not limited to, population, labour force and demography.

Economists often draw on **natural (experiments) data** for forecasting when experimental studies are impractical or unethical.[16] For example, unplanned differences or changes in situations are used to estimate behavioural responses, such as the impact of a change in income or price on demand, i.e., estimated income and price elasticities (see Box A1.2). Elasticities are obtained from studies that consider the impact of changes in demand and supply on prices or income.

Box A1.2: Use of elasticities to forecast changes in outcomes

Generic income or price elasticities derived from multiple studies are a related form of meta-analysis. There are many published price elasticities of demand for goods, examples include water, electricity, public transport and petrol.

Take care transferring generic or average elasticities to a new context. Demand and supply elasticities can change in response to demographic factors, income levels and availability of substitute goods, and importantly relate to a timeframe. For most goods or services, it is important to clarify between short-run and long-run elasticities that may change over time in unpredictable ways.

Establishing causal relationships between initiatives and outcomes using natural data is challenging due to a **lack of random assignment**. This places a large weight on econometric methods to determine cause and effect.

Time series data typically draws on aggregate or average data over time for a single variable. The use of averages may limit the ability to infer outcomes about individual behaviour. **Cross-sectional data** includes data on individuals across many variables at a point in time, however it is important to understand how characteristics of individuals may affect outcomes.

Panel data combines time series and cross-sectional data by following a set of people over time and may draw on aggregate comparisons between countries, between states within a country, or on longitudinal data on individuals. In cross-country or cross-state studies, the analyst explores the effects of national or state differences on the outcomes of comparable initiatives. Differences in

15 See Galama TJ, Lleras-Mulney A and Kippersluis HV (2018 January) 'The effect of education on health and mortality: a review of experimental and quasi-experimental evidence' (Working Paper No. 24225), http://www.nber.org/papers/w24225, for a review on quasi experimental evidence regarding the effect of education on health and mortality.

16 Also known as observation data in statistical or econometrics textbooks.

other economic or social factors, however, may also influence behaviour and be difficult to model precisely. Panel data can suffer from the same econometric problems experienced with time series and cross-sectional data.[17]

Some studies use **longitudinal panel data** to infer how long-term changes in individual circumstances influence individual outcomes. The Melbourne University HILDA survey is well established as a high-quality Australian longitudinal survey. As with other approaches, care is needed to model all the critical factors and their interrelationships.

Non-experimental designs can also use **descriptive or observational data**. The former includes simple point-in-time statistics that describe the existence of an occurrence and may sometimes be useful to forecast the base case. The latter can examine changes for participants before and after an initiative's implementation (i.e., pre-post studies) or provide context for changes caused by the initiative and identify external factors influencing change.

Non-experimental designs alone provide weaker evidence that the initiative **caused** the observed outcomes. Non-experimental designs are useful for providing context and narrative to the CBA.[18]

Finally, where relevant data is not available, as a fallback, CBA may draw on independent **expert advice**. Where the opinions of experts are the best form of evidence available, it is good practice to instead seek out the views of multiple experts to triangulate findings. Table A1.1 provides some useful references to non-experimental data sources.

Table A1.1: Common sources of forecasting evidence

Data Source	Description
NSW Common Planning Assumptions	NSW Common Planning Assumptions are the agreed information assets (data sets, parameters and assumptions, models, and analytical tools) used by NSW Government and external stakeholders to prepare proposals, that rely on projections. They provide a consistent evidence base to use in planning for key services and infrastructure in the state, from schools and hospitals to roads and transport.
Australian Bureau of Statistics Key Economic Indicators	The ABS is a useful place to start searching for general economic indicators. It provides an overview of key economic statistics used in forecasts containing information on national accounts, consumption and investment, production, prices, labour force and demography, incomes, and lending indicators.
Commercial data, market research providers	Commercial providers exist that provide industry research on thousands of industries worldwide. These data providers may provide parameters that can assist to estimate economic surplus or provide a reasonable proxy.
Household, Income and Labour Dynamics	The Household, Income and Labour Dynamics in Australia (HILDA) Survey is a household-based panel study that collects valuable information about economic and personal wellbeing, labour market dynamics and family life. It aims to tell the stories of the same group of Australians over the course of

17 Panel data is a form of longitudinal data for which observations of the same cross-sectional subjects are made over time for a sample group.

18 See Achelrod D, Blankart CR, Linder R, Von Kodolitsch Y and Stargardt T (2014) 'The economic impact of Marfan syndrome: a non-experimental, retrospective, population-based matched cohort study', *Orphanet Journal of Rare Diseases* 9, 90. https://doi.org/10.1186/1750-1172-9-90, for an example of non-experimental study design.

Data Source	Description
in Australia (HILDA) Survey	their lives. Other integrated datasets are available from the ABS such as Multi-Agency Data Integration Project (MADIP) etc.[19]
Business Longitudinal Analysis Data Environment (BLADE)	The Business Longitudinal Analysis Data Environment (BLADE) is an economic data tool combining tax, trade, and intellectual property data with information from ABS surveys to provide a better understanding of the Australian economy and business performance over time. Authorised researchers use BLADE to understand how businesses fare over time and the factors that drive performance, innovation, job creation, competitiveness, and productivity. It can provide new insights into the development and evaluation of government policies, programs, and services.

19 MADIP is a secure data asset combining information on health, education, government payments, income and taxation, employment, and population demographics (including the Census) over time. It provides whole-of-life insights about various population groups in Australia, such as the interactions between their characteristics, use of services like healthcare and education, and outcomes like improved health and employment.

Appendix 2: Valuation

This appendix contains the following sections:

- Valuation principles: opportunity cost and willingness to pay (or accept)
- Valuation methods: market and non-market (including benefits transfer) prices

A2.1 Valuation principles

Where valuation of goods and services is possible, two key concepts are relevant: the **opportunity cost** principle and the **willingness-to-pay** (or willingness-to-accept) principle.

Opportunity cost

Committing resources to an initiative precludes their use elsewhere. **The value of these resources in their most attractive alternative use is their opportunity cost**. Market prices usually reflect the opportunity cost of resources.

Resources used in an initiative should generally be valued in CBA at their opportunity cost, even if the agency can access them at less than market price.

For example, if an initiative proposes to use land that the agency already owns, then the land might appear to be costless. However, in the base case (where the initiative does not proceed), the land could be used for an alternative purpose. Therefore, the cost of the land in the CBA should reflect that alternative use foregone, represented by its market value.

Similarly, the opportunity cost of labour used in an initiative is equal to the value of the worker's output in their next best employment. In a competitive market, this is equal to the worker's highest alternative wage. However, where workers have occupational preferences, the real cost of employing someone is their reservation wage – the minimum amount that will attract the worker into a specific job.

Based on the opportunity cost principle, benefits of an initiative could be estimated based on the avoided cost of delivering public services no longer required. For example, the benefits of an early intervention policy could be valued at the avoided cost of delivering policing, courts, or incarceration services. Similarly, the benefits of a preventative health measure could be valued at the avoided costs of the acute medical services no longer required.

Willingness to pay

Willingness to pay (WTP) is **the maximum amount an individual or a firm is willing to pay for a good or service**. In CBA, goods and services are generally valued at the highest amount of money that individuals or firms are willing to pay for them.

Willingness to accept (WTA), a related concept, is the amount that individuals or firms are willing to accept in compensation for the loss of a good or service (e.g., loss of an environmental good like clean air).

The difference between WTP and WTA is based on the analyst's assumption on whether the individual or firm had a right to the good or service in question in the base case. In the former, no good or service is provided without action, in the latter, the good or service is available (or potentially available) to the individual or firm and the action denies its use.

Prices in competitive markets reflect the value of the good or service to the marginal consumer (this is assumed to remain the case if an initiative causes small or marginal changes in output or price

levels). Consumer surplus is equal to the difference between a consumer's maximum willingness to pay for a good or service and the price actually paid.

A2.2 Valuation methods

Market-based valuation methods (prices)

Benefits and costs in CBA should be valued at market prices whenever prices or reasonable proxies are available. As discussed, prices in competitive markets reflect the principles of opportunity cost and willingness-to-pay.

Market-based valuation relies on analysis of market information on consumer behaviour and prices in similar, complementary, or related markets.

Market-based prices are relatively straightforward for estimating costs, such as materials and labour. The cost of acquiring an asset can be valued based on:

- replacement cost at current market prices (as opposed to book value), or
- damage (mitigation) cost, the cost of works to prevent damage to an asset.

Market data can also be used to value benefits. For example, wage premiums for students at different levels of achievement can be used to value the productivity benefits of education.

Market prices in substitute or complementary markets can also be used to value some benefits. For example, the value of treating water to improve safety and quality could be inferred from the market price of bottled water.

When markets are competitive, market data can directly provide information required for CBA. When markets are not competitive, however, prices may need to be adjusted to reflect real economic values.

Adjustments to prices to reflect true cost (shadow prices)

A shadow price is an estimate of a price when:

- a market price is not available, e.g., use of national parks (that can be measured using revealed or stated preference) discussed in the following section, or
- the market price is known to be distorted. In this instance a subsidy (tax) on production will lead to a lower (higher) price than the true economic cost.

The use of shadow prices (i.e., adjustments to observed market prices to reflect the real cost of a good or service) could be considered where:

- Taxes and subsidies drive a substantial wedge between the real costs of production and prices. If an initiative results in a domestically produced good's output increasing, then the price less any indirect taxes and subsidies is the true economic cost. If the good is in fixed supply, the full market price should be used (including any taxes and subsidies).
- The resource used (non-labour inputs, labour) would otherwise be unemployed or under-employed so that the opportunity costs of labour employed on an initiative are less than the wage costs and the initiative's costs could be adjusted accordingly.

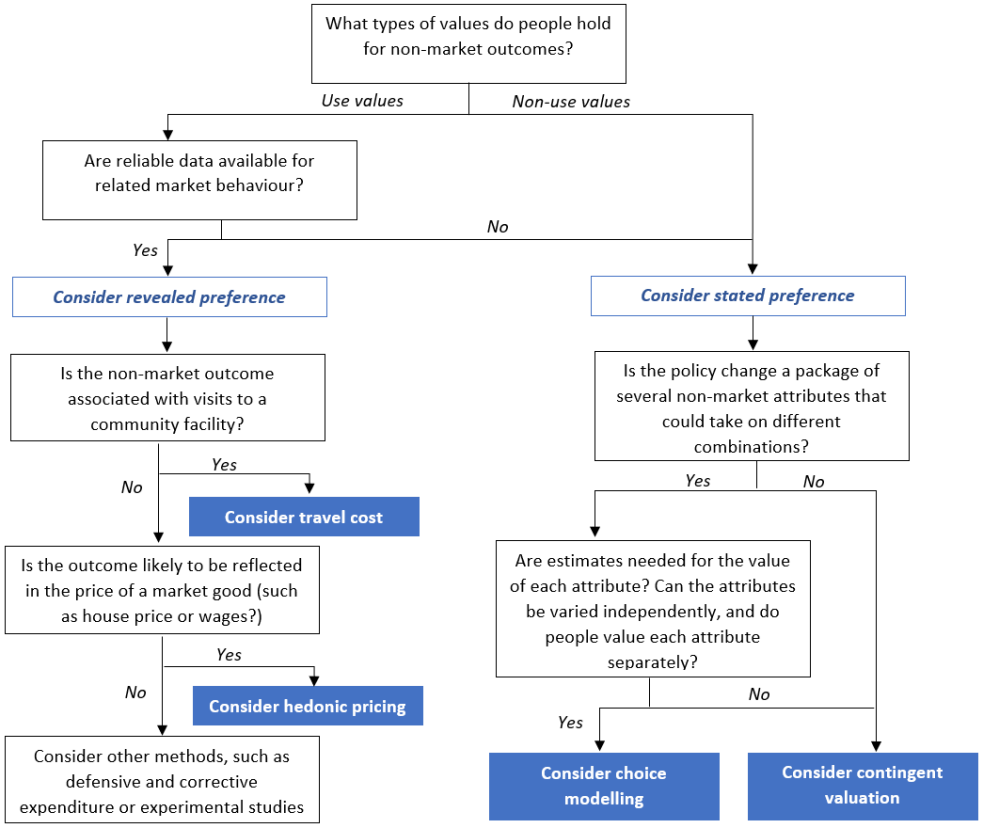
Shadow price adjustments **for use of resources (labour, non-labour inputs to production, land) are not commonly used in Australia**, and this Guide cautions doing so due to the significant measurement complexities involved.

Non-market valuation methods

Non-market valuation methods may be required when markets for a good or service are not available or are heavily distorted. Values generated from non-market valuations are typically called 'shadow prices'. Some common non-market outcomes have pre-established methods of valuation and standard parameters available from the NSW Government, for example, non-traded outputs such as travel time savings for transport projects.

Selecting the appropriate non-market valuation approach is based upon several factors that include the type of values that individuals hold for the outcome (use, non-use, or both) and the quality and availability of data. The most important aspect is ensuring the valuation measures the specified outcome. Figure A2.1 provides a framework for selecting non-market valuation approaches to use. **When non-market valuation methods are used, all else equal, revealed preference methods are likely to be more reliable than stated preference.**

Figure A2.1: Selecting a non-market valuation method — initial questions



Source: Treasury based on Baker and Ruting (2014) Environmental policy analysis: a guide to non-market valuation, productivity commission staff working paper, p. 51.

Revealed preference methods

Revealed preference (RP) methods estimate consumers' willingness to pay (WTP) by examining their actual behaviour. The four main revealed preference methods are hedonic analysis, travel costs analysis, defensive expenditure, and special experimental studies.

Hedonic analysis conceptualises goods as 'bundles' of attributes and assumes that the price of the good is the sum of the value of these attributes. Regression analysis can then be used to determine the values of the attributes (i.e., 'correlation' between the price of the good and a change in its attributes). Two major applications are hedonic analyses of house prices to elicit non-market environmental values and wages to elicit returns to education.

For example, a hedonic analysis could estimate worker earnings as a function of years of schooling, while controlling for relevant factors like work experience, industry and demographics, to estimate the price of schooling in the labour market.

Box A2.1: Hedonic analysis

Criteria to help determine the quality of a Hedonic study:

- Data sources and any transformations of data are clearly specified.
- The market is characterised by many transactions, and any regulatory distortions to prices are considered in the analysis.
- Justifications are provided for the scope of the market used in the analysis (such as the geographic scope of a housing market), and alternative definitions are tested where appropriate.
- Where data on all relevant attributes are not available, the potential impact of any omitted variables is discussed.
- Variables used in the statistical model are carefully chosen to reduce multicollinearity or endogeneity.
- Implicit price estimates are only used to value small or marginal changes in attributes.

Travel cost studies are used to value community facilities, such as parks and recreational sites, that generally have no, or very small, entry fees. The travel cost method assumes that visitors to these sites still incur costs in the form of time, transport, and accommodation. Data collected on these costs is used to estimate the demand curve and consumer surplus — **travel costs themselves are not the actual shadow price of the non-market good or service**. A critical assumption of the travel cost method is that the trip has a single purpose. If a trip has several purposes the travel costs must be allocated between them.

Box A2.2: Travel cost studies

Criteria to help determine the quality of a travel cost study:

- Data and assumptions relating to the costs people incur when travelling are clearly set out.
- Attempts are made to determine what proportion of these costs can be attributed to the site of interest, based on responses to the survey.
- Substitute sites are considered in the statistical model.
- The treatment of multiple-purpose and international visitors in the analysis is clearly specified.
- Justification is provided for the value placed on the time cost of travel.
- The information and questions in surveys are clear and unambiguous. Sampling techniques are explained and response rates identified.
- A copy of the survey instrument is attached to the study.

Defensive and corrective expenditure is expenditure that mitigates the negative impact of an event before it occurs or reduces damages after it occurs. The value of goods can be inferred from

defensive expenditure by assuming that a consumer will purchase goods and services up to the point where marginal benefits are equal to marginal costs.

This method, however, must be used with care as some expenditures are lumpy (e.g., household solar systems). Corrective expenditures that restore the individual or asset to their previous, undamaged state represents what parties are willing to pay for the good or service involved. A common example is health care expenses to treat illnesses arising from pollution (sometimes described as the cost of illness valuation method).

Experimental studies, including field and laboratory studies, can also provide valuation information. Some studies have shown that lab experiments on social dilemmas can be valid outside the lab environment. Caution, however, is required when extrapolating results, for example:

- Laury and Taylor (2008) found that the amount contributed in a public good lab experiment was positively correlated with the willingness to contribute money to a local tree-planting organisation[20]
- Ilona et al. (2019) found that lab based public good games were positively correlated to real world outcomes in the case of free riding in university assignments[21]
- Saldarriaga-Isaza et al. (2019) found that decisions made by university students in a public good lab experiment correlated to what artisanal gold miners decided in a lab-in-the-field experiment.[22]

Therefore, it would be prudent for this type of analysis to be reviewed by behavioural economists early in its development to ensure findings can be applied beyond the lab.[23]

Stated preference methods

Stated preference (SP) methods ask individuals to self-report their preferences or valuations, the two main methods are:

- Contingent valuation – Surveys asking consumers how much they are willing to pay to retain (or avoid) something. This may be in the form of a binary (yes or no) answer in response to a given price or range of prices. This method has been widely used, mainly to value environmental programs.
- Choice modelling techniques[24] – Surveys typically asking respondents to select from a number of pre-defined options. Each option is described in terms of different levels of a common set of attributes. Analysis of the trade-offs between attributes and price provides monetary valuations of the attributes.

20 Laury S and Taylor L (2008) 'Altruism spillovers: are behaviours in context-free experiments predictive of altruism toward a naturally occurring public good', *Journal of Economic Behaviour and Organisation*, 65(1):9-29.

21 Reindl, Ilona, Hoffmann, Roman, Kittel and Bernhard (2019) 'Let the others do the job: comparing public good contribution behavior in the lab and in the field', *Journal of Behavioral and Experimental Economics* (formerly The Journal of Socio-Economics), Elsevier, 81(C):73-83.

22 Saldarriaga-Isaza A, Villegas-Palacio C, and Arango S (2019) 'Chipping in for a cleaner technology: experimental evidence from a framed threshold public good game with students and artisanal miners'. *Journal of Behavioural and Experimental Economics*, 78, 10-16.

23 Further, experimental studies should be grounded in the methodological approach set out by Vernon Smith (1976, 1982) as discussed in Alm J and Jacobson S (2007) Using laboratory experiment in public economics. Article in National Tax Journal and mindful of the 12 actions that might help to alleviate the 'credibility crisis' discussed in Czibor E, Jiminez-Gomez D and List JA (2019 January) *The dozen things experimental economists should do (more of*) (Chicago Experiments Initiatives Working Paper No. 2019-01), https://www.nber.org/papers/w25451.

24 See for example Hensher D, Rose J and Greene W (2005) *Applied choice analysis: a primer*, Cambridge University Press.

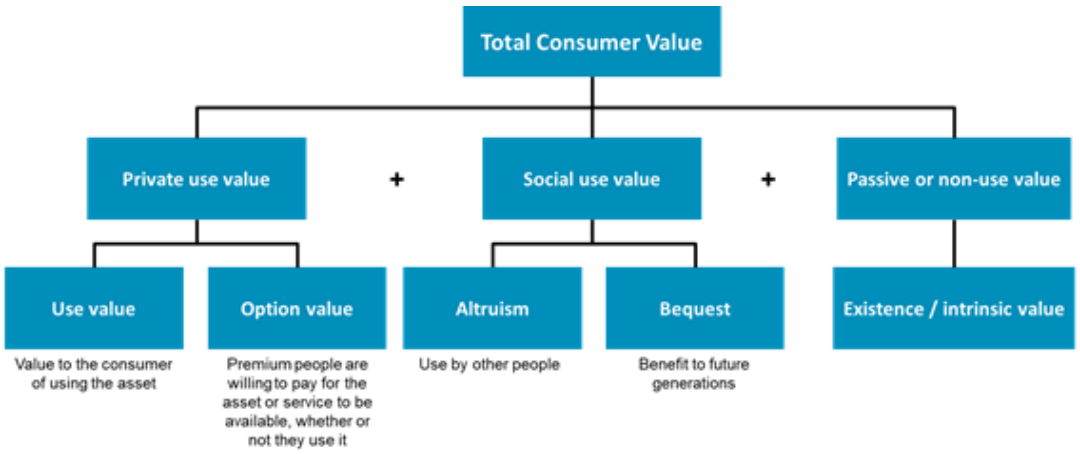
SP surveys can measure WTP on an individual or household basis and this unit of analysis should be made clear in CBA. **Household WTP is generally preferred over individual WTP** as previous studies[25] suggest that adding up WTP of individuals in a given household tends to result in overstating the WTP of the household as a whole.[26] The CBA should clearly specify whether the WTP estimate is measuring:

- Consumer benefit deriving from **use**, i.e., an individual's or household's willingness to pay for the consumption of a good or the service being provided by the proposed project or program, or
- Non-consumer benefit deriving from **non-use** – this could include any or a combination of altruism, existence value, or option value (see Figure A2.2).

In practice, the two measures are likely to differ in respect of how they are counted in the benefit streams of a CBA. Typically, consumer benefits deriving from use of a public good or service **should be estimated over the entire CBA analysis period and not as a one-off up-front benefit or payment**.

Where a **WTP for non-use** estimate is valid, it may be counted as **a one-off up-front benefit or payment** which can potentially offset the real resource cost of the program, consistent with the timing of the receipt of expected payment (e.g., at commencement of construction or operation, or staged over a multi-year construction period).

Figure A2.2: Theoretical components of consumer value[27]



SP techniques often rely on survey responses and econometric analysis of results and surveys are subject to several well-known challenges including hypotheticality, biases, and strategic responses.

If multiple SP surveys exist for a non-market good, then it is recommended to present the findings from each survey in the CBA, because:

25 See for example Quiggin J (1997) 'Individual and household willingness to pay for public goods', *American Journal of Agricultural Economics*; and Lindhjem H and Navrud S (2008) 'Asking for individual or household willingness to pay for environmental goods – implication for aggregate welfare measures'. MPRA Paper No.24070.

26 There are also different WTP concepts that may apply to these services. For example, WTP for the consumption of a good or service (a private use value) is different from WTP to enable the provision of the service (a non-use value to a donor). It is appropriate to treat the two concepts differently in a CBA.

27 The chart is adapted from previous work on applied environmental economics. See for example Figure 1.1 in Bateman I, Lovett A and Brainard J (2003) *Applied environmental economics*, Cambridge University Press and Figure 2.1 in Smith M, de Groot D and Bergkamp G (2006) *Pay-Establishing payments for watershed services*, International Union for Conservation of Nature, , Switzerland, 109.. This variation was developed by NSW Treasury's First Nations Economic Wellbeing team.

- This can validate the estimated valuation by presenting multiple, similar results.
- Where results are varied between surveys, robust CBAs will provide insights as to why estimates are varied. This could include environmental considerations, population differences or other structural effects.
- Where estimated prices for the same good vary, the estimate based on quality evidence and characteristics that closely align to the good are preferred.

Commissioned SP studies can help build the evidence base for future CBAs. SP reports do this by including details that will make it easier for future CBAs to transfer the results into a similar context. Ideally, this will include estimating a benefit transfer equation.[28,29]

Treatment of willingness to pay estimates in CBA

Where possible, WTP measures in a CBA should aim to distinguish between private use value and all other values **to avoid double-counting of benefits**. Where an aggregate WTP measure includes non-use values that cannot be separated from private use values or option value, the CBA should state this clearly and the assessment of validity should consider the plausibility of the aggregate WTP measure.

In practice there is likely to be significant overlap between various categories of consumer value, particularly non-use values such as in the following cases:

- With cultural, natural, or environmental assets, it can be difficult to distinguish between and separately estimate the various categories of non-use value and private option value.
- It may be possible for non-use value to account for the bulk of benefits from significant natural or environmental assets.
- Built assets with a primary value ultimately residing in their use would be expected to derive most (if not all) of their benefits from private use value – e.g., stadiums, cultural or recreational facilities. Where this is not the case, the CBA should rigorously document the validation procedures used.

Option value is excluded as it is often not possible to confidently sign or quantify it.[30]

Where non-use values do not meet the required validity tests, these values should be included in sensitivity tests, where the CBA presents supporting information, these benefits exist and are attributable to the initiative.

Wellbeing Valuation

Wellbeing valuation starts with an analysis of people's overall life satisfaction and then applies econometric methods to estimate the life satisfaction provided by specific non-market goods. It then converts these into a monetary value using an estimate of the relationship between income levels and life satisfaction.[31] This approach is similar to 'Social Impact' or 'Social Value' assessment

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28 HM Treasury, Supplementary Guidance: Economic Valuation with stated preference techniques, 72-73.

29 Baker R and Ruting B (2014) 'Environmental policy analysis: a guide to non-market valuation' Productivity Commission Staff Working Paper, Productivity Commission, Canberra, 44-48, provide further discussion on how to consider including SP results from a study in a CBA.

30 Boardman AE, Greenberg DH, Vinning A and Weimer DL , (2018) *Cost-benefit analysis – concepts and practice*. 5th ed. Cambridge University Press, sections 12.2-12.4. As discussed in Boardman et al (2018) option value is the difference between option price and expected surplus, the latter is what is usually measured.

31 UK Treasury (2011)Green Book: Appraisal and evaluation in central government58. For an example applying this approach, see Trotter L, Vine J, Leach M and Fujiwara D (2014) *Measuring the social impact of community investment: a guide to using the wellbeing valuation approach, housing associations charitable trust*.
(http://www.hact.org.uk/sites/default/files/uploads/Archives/2014/3/MeasuringSocialImpactHACT2014.pdf?sid=9120).

or measurement, developed more recently.[32] Note, CBA is explicitly seeking to measure wellbeing using monetised units, wellbeing valuation is not a separate approach to CBA that includes additional information.

Data sources and methodology for deriving wellbeing value estimates in Australia **should be rigorously documented**, particularly if intended for use in future CBAs. Triangulation of estimates from multiple surveys is encouraged. Triangulation is the process of comparing findings with those found elsewhere, including other countries, regions, or times, alongside a logic check of why similarities or differences between values exist.

Subjective wellbeing estimates are not generally expected to coincide with conventional SP valuations. Triangulating results is not just to assess if valuations produce the same answer, but whether differences in results are plausible due to methodological differences.[33]

As wellbeing valuation is an emerging field, this Guide recommends that, all else equal, **core CBA results must be based on established non-market valuation approaches such as revealed preference or stated preference methods**. Results based on wellbeing valuation could, in future, be shown separately in sensitivity analysis, but Treasury should be consulted before this work is undertaken.

Benefit transfer

Benefit transfer draws valuations from existing studies to use as proxy values for benefits or costs of the current initiative.

Benefit transfer is increasingly being used in Cost-Benefit Analysis due to its practicality. While there are known limitations due to differences in contexts between the original study site and proposed site, it is widely accepted as a reasonable method in many circumstances.

Selecting studies for benefit transfer

Two key questions for transferring values from an existing study are:

- Is the original study of high quality and has it produced unbiased estimates?
- Is the value in the original study applicable to the context of the current initiative?

Benefit transfer is only as good as the underlying study from which it transfers. While lower quality values can still be transferred, the confidence around the estimate may diminish. It is recommended to document areas of uncertainty in the CBA.

Before selecting studies for transfer, analysts must clearly define the context of the current intervention (e.g., demographics and location).[34] It is essential that there is a high level of comparability between the study sites being considered, including a relevant operating environment, jurisdiction and context. In practice, this is not always possible, therefore transparency is important in the benefits transfer process. Table A2.1 provides a checklist to apply when considering using benefit transfer.

32 Note: this is not the same as 'social impact assessment' required by NSW environmental legislation.

33 See, UK Wellbeing Guidance for Appraisal – Supplementary Guidance Annex 3 for further information.

34 Rolfe J, Johnston RJ, Rosenberger RS and Brouwer R (2015) *Benefit transfer of environmental and resource values: a guide for researchers and practitioners*. Springer.

Table A2.1: Benefits transfer checklist[35]

Considerations	Description
Policy context	This helps selecting relevant primary studies to transfer. For example, if the project is about air quality, then studies on air quality are more relevant for transfer.
Definition of the entity	The quantity or quality of the good or service must be similar, but so must the impact of the scenario on the entity, and the intended use of the entity. For example, if a study provides a WTP estimate for protecting public open space for recreation benefits, these benefit values could not be applied to conserving biodiversity.
Quality of the study	The quality of data collection and estimation will affect the transferred values.
Socio-demographics of the population	The socio-demographics between the sites must be similar for values to be transferred. This includes age, gender, income levels, income distribution, and education.
International differences	If transferring from an international study, differences in culture, currency, and wealth should be considered.
Scale differences when aggregating	Are there differences between the benefits being valued in the original study and the new context, such as population sizes? Population differences may be solvable by aggregating on a per head basis.
Scope effect	A scope issue arises when a WTP estimate is applied to a change in the project case that exceeds that for which it was estimated. For example, the value that an individual places on living near a park depends on how many other available parks there are. The value of the resource change (i.e., number of parks) cannot be estimated by multiplying a value from the literature for a specific resource change by the ratio of the resources of the policy and study sites.

Methods for transferring valuations

There are two common methods to conduct benefit transfer: **unit value transfer** and **benefit function transfer**.[36]

Unit Value Transfer

Unit value transfers take an estimate or set of estimates directly from an existing study. Unit value transfers are either unadjusted or adjusted.

35 Iftekhar MS, Gunawardena A, Fogarty F, Pannell D and Rogers A (2020) *INFFEWS value tool: guideline (Version 3): IRP2 comprehensive economic evaluation framework (2017 – 2019)*. Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities.

36 Boyle KJ, Kuminoff NV, Parmeter CF and Pope JC (2010) 'The benefit-transfer challenges', Annual Review Resource Economics, 2(1):161-182.

- Unadjusted unit value transfer assumes marginal values are the same between the existing study and the current initiative, i.e., a direct unit transfer of average WTP estimates.
- Adjusted unit value transfer adjusts the estimates taken from the original study to better reflect the context of the current initiative.

Adjustments to WTP estimates are only advised when the method of adjustment is well evidenced. Generally, more complex adjustments reduce confidence in the transferred estimate.

Some key points to consider when transferring unit values:

- When the quantity or quality of a good or service differs between the original study and the current initiative, there is a risk of values being over- or under-estimated.[37] For example, if an existing study on the value of green space near homes estimates WTP of $100 per person to live near a one-hectare park, then a current initiative to provide a 100-hectare park cannot assume WTP of $10,000. In the presence of declining marginal utility, this would be an over-estimate.
- Caution is also required if benefit transfer aims to apply valuations elicited from a particular socioeconomic group in the original study to a larger population in the current initiative.
- For values that are transferred, an upside and downside sensitivity test should be included (guided by the range of estimates, i.e., the standard deviation units).

Benefit Function Transfer

A **benefit function** is an estimated relationship between the WTP estimate and a set of variables. The set of variables could include quantity and quality of the good or service being valued, characteristics of the site, and characteristics of the population.[38]

Benefit function transfers have two main requirements:

- A regression model, or some parameterised function, to calculate the WTP as a function of variables (e.g., green space, number of schools, house prices) reflecting conditions in the original study.
- Information on those variables for the current initiative, so the transferred function can be applied.

Two potential errors are likely to occur with benefit function transfers:

- **measurement errors** due to errors within the original study, like methodological errors or biased estimates
- **generalisation errors** arising during the transfer of values, like incorrect benefit scaling or low transferability.

Benefit functions are generally regarded as more accurate than direct unit value transfers due to the ability to adjust for differences between the original study and current initiative. However, these adjustments also increase the likelihood of generalisation errors, and the data and expertise required for benefit function transfer is a significant challenge.

37 Rolfe J, Johnston RJ, Rosenberger RS and Brouwer R (2015) *Benefit transfer of environmental and resource values: a guide for researchers and practitioners*, Springer.

38 Iftekhar MS, Gunawardena A, Fogarty F, Pannell D and Rogers A (2020) *INFFEWS value tool: guideline (Version 3): IRP2 comprehensive economic evaluation framework (2017 – 2019)*. Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities.

Appendix 3: Common issues in CBA

This appendix provides guidance on a range of practical issues in CBA, including:

- Considerations associated with the analysis period
- Treatment of the factors of production
- Practical issues in CBA
- Carbon emissions
- Items that should be excluded from CBA
- Transfer payments (including discussion of grants and taxation)
- Additionality, displacement, and leakages

A3.1 Considerations associated with the analysis period

When it differs between projects (project comparison)

In practice, a single CBA may assess options with **different analysis periods** due to the assets or interventions proposed having different periods of economic life, e.g., a dam versus a desalination plant or a capital project versus a non-build option. However, when comparing projects, **the analysis period should be the same for all options** (even if assets have differing economic lives) **and should have the same base year** for calculating present values.

The analysis period for each option should match when options are **mutually exclusive** (i.e., different versions of the same project, where only one would be implemented). If options have different economic lifespans, then adjustments need to be made to ensure NPVs are comparable. Analysts can either:

- model the shorter option as a repeated initiative (with roll-over or replacement)[39] through the lifespan of the longer option (up to a common multiple in years for both), or
- calculate an equivalent annual value for each option.[40]

The BCR is valid when comparing independent initiatives with different analysis periods.

When it differs with the asset life (residual value)

In general, the analysis period for an initiative should match the lifespan of the key assets delivered, meaning the default assumption is usually that assets reach the end of their economic life by the end of the analysis period and have zero residual value. Alternatively, the asset may reach the end of its economic life but has a 'scrap' value, which can be counted as a benefit at the end of the analysis period.

39 Note: For simplicity, this method assumes identical versions of the project are roll-over or replaced. This may not be observed in reality if a more efficient or enhanced version of the project would likely be available in the future. Clearly, more flexibility, reduced risk, and potential for technology advancements may be associated with the project that is repeated more. Theoretically, there may be benefits associated with these considerations (see Boardman et al 2018 s 9.4), but it is difficult to determine both the sign and magnitude of option value (see Boardman et al 2018 s 12.2).

40 Convert option NPV into an annuity: EAV = (SDR x NPV) ÷ (1- (1+SDR)-N); where N is time (i.e. the analysis period), SDR is the discount rate. Treasury can provide support with this approach if required.

In cases where an asset has not reached the end of its useful life in the analysis period, a residual value benefit should be included if the asset is still of use or there is a market for its resale. Residual values may be based on the **lesser** of replacement cost, considering the age of the asset, or the remaining present value of net future benefits attributable to the asset beyond the analysis period.

The most common (practical) approach to account for residual value is applying straight-line depreciation to the asset's lifespan. Analysts should ensure realistic assumptions on asset lifespans are used. Supporting information on the effective life of assets may be found using ATO rulings or official guidance from agency corporate finance teams.

A3.2 Treatment of the factors of production

Capital (pre-existing buildings or plant)

Any plant used in the initiative should be valued at its value in alternative use. Sale value may be used for highly marketable assets (e.g., motor vehicles). Where resale markets do not exist, the particular plant may be valued by the lesser of either the:

- estimated present value of the plant's savings or revenue earnings potential in its current location or activity, or
- current replacement value of the plant, i.e., not the book value of the plant, adjusted for the residual life of the existing plant where appropriate.

Overheads

Overheads such as supervision, administrative costs, printing, and stationery, are also included in costs if they differ between options and the base case. Material overhead costs associated with purchasing, storing, and transporting materials needed for the project or program will also be relevant.

Labour

The cost of labour in a CBA is its opportunity cost, which is the reservation wage. That is, the lowest wage rate that a worker would be willing to accept for doing a particular job in a particular location. The reservation wage differs between employed and unemployed (or underemployed) persons.

Where an initiative uses **in-house labour**, the value of existing labour resources and any additional labour (i.e., new hires) allocated to the initiative should be included in the initiative's costs. For practicality, the cost of in-house labour can be assumed to be equal to actual wages and on-costs of the employees.

Labour on-costs (e.g., superannuation, workers' compensation, long service leave and other statutory or contractual obligations of an employer that comprise part of labour-related expenses) are incremental, unavoidable costs that are added to direct labour costs and included in cost and/or savings estimates.

Where an agency uses subcontractors, the agency should, where possible to obtain, include in the cost estimate a breakdown of the amount to be subcontracted into separate components for labour, capital, and other significant cost categories. This would facilitate comparison with other procurement options.

Returns to NSW labour

As discussed in Chapter 2, factors of production such as labour may receive payments over and above the minimum amount that is required to obtain their use. Labour surplus can theoretically be

generated by an initiative causing either increases in wages or increases in employment, for example:

- If an initiative increases demand for NSW labour — whose supply is somewhat inelastic — wage rates may be higher than the employees' reservation wage and the incremental increase would therefore be a labour surplus benefit.
- If an initiative increases employment, this can result in a labour surplus benefit provided that the **workers employed do not displace workers employed elsewhere** in the economy.

In a competitive labour market, it is unlikely an initiative will cause **ongoing** changes in labour surplus compared to whole-of-economy structural reforms. Impacts on **labour surpluses from an initiative are likely to be medium term** (when the economy can be assumed to find a new equilibrium).[41]

Some initiatives may attract new workers from outside New South Wales. If including workers from outside New South Wales, labour surplus for those workers should be **reported separately** for workers currently in New South Wales and workers expected to re-locate to New South Wales, as the latter are generally considered to be outside the referent group.

Land in CBA

Opportunity cost of land

A project may use land, buildings or plant already owned by a government agency, for which no payment will be made. In these cases, **the opportunity cost of the assets should still be included in the CBA**.

For land and buildings, CBA should use a valuation based on the most profitable alternative use (see Box A3.1). In some cases, this may mean considering realistic changes to zoning that could occur in the near future.

Box A3.1: Land valuation data

Expert advice on land valuation is available from the NSW Valuer General (NSW VG).

The NSW VG provides land valuations through their website for all land in New South Wales (see https://www.valuergeneral.nsw.gov.au/). Their valuation approach values land as if it was vacant, based on its highest and best permitted use, given current zoning, and planning restrictions. Generally, published NSW VG land valuations should be used in CBA unless:

- the initiative is very large and land use change is a key outcome (e.g., urban renewal or city-shaping public transport), in which case expert advice should be sought
- the published NSW VG valuation does not reflect the latest conditions or land use changes (zoning and planning) in the area
- there is a specific land use change identified in the project that is more realistic as a likely highest value to be used.

41 Bartik TJ (2015) 'The social value of job loss and its effect on the costs of U.S. environmental regulations'. *Review of Environmental Economics and Policy*, 9(2):179–197.

Land value uplift

Land values may be influenced by an initiative if it makes an area more (or less) accessible or attractive to live or work in. The Guide refers to this as land value uplift. **Typically, land value uplift is a result of the benefits delivered by an initiative.**

For example, an improvement to a public park may result in land value uplift for nearby homes because residents can use the improved park. The value of using the park is capitalised into land values. However, a CBA of the park improvement will directly measure the benefit to users of visiting the park, based on their use values. Therefore, directly counting use value and land value uplift in the CBA would amount to including the same benefits twice.

Generally, CBA should directly measure the value of benefits and exclude land value uplift in order to avoid double-counting.

The exception may be instances where directly monetising benefits is not feasible and land value uplift is a useful proxy measure (e.g., hedonic analysis). Land value uplift is likely to reflect a combination of factors in uncertain proportions, so it is preferable to use only land value uplift **or** only direct measurement of benefits, rather than a combination of techniques to measure different benefit streams.

Higher value land use (HVLU)

Land value impacts can also enter a CBA through changes in land use. Some initiatives may change the amount or type of floor space (e.g., housing or offices) that can be delivered on a given piece of land. It is most common in large transport projects where development opportunities previously unviable due to network congestion or capacity constraints are now unlocked.

The Guide refers to this as higher value land use. Forecasting and valuing higher value land use is a complex and evolving practice (see Box A3.2). Australian Transport Assessment and Planning guidance (08 Land Use Benefits) is a valuable resource that contains significant additional details. Higher value land use benefits are difficult to predict and attribute to specific interventions. All costs required to realise the higher value land use impacts must also be considered.

The Guide recommends that separate CBA results are presented excluding and including higher value land use benefits.

Box A3.2: Key points to consider for higher value land use

Land use changes in the base case

- Rezoning, development, and timing assumptions without the initiative.

Current potential may exceed current reality

- In some cases, the current level of development in the project area may be lower than the maximum allowed under existing planning limits.
- This may be because there is insufficient infrastructure to support further development.
- If so, then an initiative that addresses the relevant infrastructure constraints may be able to ‘unlock’ further development even without a change to planning limits.
- However, the CBA should also consider whether the level of infrastructure, and therefore level of development, might also increase in the future in the base case.

Box A3.2 continued: Key points to consider for higher value land use

Attribution

- Only changes in land use above and beyond the base case land use can be attributed to the initiative.
- As discussed above, the base case level of development may be higher in the future than it is at present, particularly if there are complementary initiatives occurring in the base case.

Developer costs and benefits

- Unless there is project-specific evidence to the contrary, the CBA should assume developers will earn an industry 'normal' return on developments undertaken due to the initiative.
- Earning a normal return means the developer's opportunity cost of undertaking the development is equal to the benefits they earn. Consequently, the net benefit to the developer from a CBA perspective can potentially be assumed to be zero.

Accounting for value of existing capital demolished

- New developments may involve replacing existing buildings earlier than they would be replaced in the base case. This cost should be accounted for in higher value land use calculations.
- The value of existing capital demolished can be challenging to estimate in practice, but best efforts should be made and all assumptions clearly documented.

A3.3 Practical issues in CBA

Double counting of benefits

The risk of double counting can arise across many aspects of CBA modelling. Some examples include:

- Impacts of an initiative are incorporated in subsequent valuations of assets or in market prices (see land value uplift discussion in Section 3.2) and both are included in the CBA. For example, directly measuring use value, amenity, and heat mitigation benefits from a new park and also including increased property values near the park as a benefit.
- Transfer payments between groups are not explicitly considered. For example, measuring the consumer's willingness to pay for a new public transport service as a benefit and adding the revenue collected by the provider as a separate, additional benefit. To avoid double-counting, the consumer benefit should be the consumer surplus (i.e., willingness to pay less price).
- There are multiple methods for measuring the same benefit, but these are not mutually exclusive. For example, an energy efficiency project could measure the benefit through valuing consumer savings based on retail energy prices, **or** it could measure the benefit based on avoided costs through the energy supply chain (lower generation costs, transmission and distribution infrastructure costs and retail costs).
- A Logic Model was not developed and there is confusion of specific, incremental changes in outcomes (therefore benefits) between the base case and project case. The quantification

approach for each benefit category may not be specific enough and therefore risks double-counting across other benefit categories.

Taking a conservative approach

In some instances, due to low confidence in supporting data (see Box A3.3) some forecasts or valuations may be less reliable. In these cases, analysts may consider **taking a conservative approach** when making assumptions about what data is used, which may ensure reliance on 'things going right' is reduced. Note, taking a conservative approach **departs from the expected (average) value approach** discussed in Appendix 2 and should be applied cautiously.

This does not mean using values outside the expected values approach, but where confidence in the forecast or valuation is low, then a conservative treatment (i.e., using a parameter at the lower-end of the available range of estimates) may be prudent. If this approach is taken it should be clearly discussed.

Box A3.3: Signs indicating low confidence in forecast estimates

- The range of results is large (indicated by the standard deviation units).
- The assumptions used are not strongly grounded by research or evidence.
- The evidence used is not relevant or valid (as discussed in Appendix 1.3) to the initiative.
- The available evidence is dated, e.g., over 10-years and especially over 20-years old.
- The results cannot be explained or validated.

Wider Economic Impacts

Wider Economic Impacts[42] (WEIs) relate specifically to city-shaping projects where changes in urban density may change productivity. These are predominantly associated with major transport projects and urban re-development but could theoretically exist for other transformational projects like precincts spanning across many sectors. Deriving estimates of WEIs will only be worthwhile and justified where changes in urban density can be realistically expected.

Efforts to quantify WEIs have focused largely on measuring increased output due to agglomeration economies, based on the concept of 'effective density' of a location.[43] 'Effective density' is defined as the employment in and around the specific project area, weighted by proximity (that declines with generalised cost of travel) to the location. Effective density generally applies to urban areas only, as it is unlikely for rural areas to generate WEIs, unless the initiative improves transport routes between a rural and urban area.

However, as has been observed, 'Productivity certainly attracts population … the basic problem with estimating agglomeration effects on productivity is that population density is not exogenous. People move to places that are more productive.'[44] Therefore, density and productivity may be simultaneously determined by some other factor.

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42 Also known as Wider Economic Benefits (WEBs).

43 UK Department for Transport (2006) *Transport, Wider Economic Benefits, and Impacts on GDP*, http://webarchive.nationalarchives.gov.uk/20080306143059/http://www.dft.gov.uk/pgr/economics/rdg/webia/webmethodology/.

44 Glaeser E (2010) '*Introduction' to agglomeration economics*, ed. Glaeser, University of Chicago press, 13-14. As referenced in Abelson P (2021) 'A critical review of the wider economic benefits of transport infrastructure', *International Journal of Economics & Management Sciences*, 10:608.

The existence of WEIs requires a 'narrative' to justify their realism and inclusion in CBA estimates. WEI analysis aims to measure benefits not normally captured by travel time savings in CBA. Box A3.4 identifies the main types of WEIs.

Box A3.4: Types of Wider Economic Impacts

There are four categories of WEIs, but the three main categories are:

- Agglomeration economies (WEI 1) – benefits of improved productivity derived from higher employment density, input and labour markets which offer the firm greater choice, and greater access to knowledge and technology of other firms.
    - Dynamic clustering reflects the location choices of firms.
    - Static clustering relates to improvements in transport network performance.
- Labour market and tax impacts (WEI 2) – benefits of lower transports costs enable greater labour force participation, increased hours worked, or allocation of workers to higher productivity jobs.
    - WEI 2a (only) relates to a change in labour supply.
- Output changes in imperfectly competitive markets (WEI 3) – a reduction in transport costs causing an increase in production or output of goods or services that use transport.

There are substantial practical issues in quantifying WEIs, including the availability of relevant data, the validity of the measures used, the conclusions that can be drawn from them, and the high risk of double counting some economic benefits.

Further, the size and direction of WEI can differ strongly across projects and a transport project can give rise to agglomeration costs due to dispersion of jobs and housing. A discussion on the **net increase** in agglomeration effects for the initiative would contribute to the narrative for WEI's inclusion in the CBA.

Given the uncertain nature and the high potential to double count benefits, **WEIs for relevant projects should be excluded from the central estimate of a CBA and be shown separately as a sensitivity analysis**.

Plausibility checks for estimates of costs and benefits

CBAs should demonstrate that the estimate of costs and benefits of the options are reasonable, particularly where:

- there is a high degree of uncertainty regarding the size or time path of benefits or costs
- the bulk of total benefits or costs are attributable to a single category of benefit or cost
- the project has a significantly higher BCR than other similar projects.

Some examples of threshold analysis that might be undertaken include cost per user or service and cost differences between options.

Cost per user or service

If benefits cannot be valued, it may be possible to use the net present cost of a proposal to determine the likely cost per user over the life of the proposal. If this amount exceeds the likely benefit to each user (for instance, measured by their total 'willingness to pay', if this measure is available), then the proposal is unlikely to be reasonable or plausible. **The basis for comparison**

between likely net present cost and benefit should be clear and consistent (e.g., per user, per service, once-off, ongoing etc.).

For example, consider a proposal to provide free services to users at a net present cost of $10 million:

- If the proposal were to benefit 10 million users, the unit cost would be $1 per user. In the absence of empirical evidence, it could be reasonably inferred that the benefit per user is likely to outweigh the cost and that users or the community would be willing to pay $1.
- Conversely, if the cost per user was $100 and it would be unrealistic to assume that users would be willing to pay $100 each when a cheaper and better alternative exists, then the proposal would fail the reasonableness check.

The estimated likely net present cost should also be benchmarked against other comparable sample projects, where applicable, using the same comparison basis. For example, the cost of rail infrastructure per track kilometre could be benchmarked against other comparable rail projects and known sample unit cost rates to identify any potential issues in scoping or efficiency.

Cost differences between options

These could be compared to determine whether the additional cost is reasonable. For example, assume two options where Option A offers improved service levels compared to Option B. If the improved service levels of Option A are relatively minor but would incur a significantly increased cost, a reasonableness check would likely rule out Option A.

The difference between economic output and welfare

On some occasions when estimating the effects of government initiatives, analysts may misinterpret the value of a change in production by an industry (i.e., output or value added) as a benefit that improves welfare to society. Social welfare and economic output are not the same, although a relationship exists between the two.

Direct measurement of changes in economic activity, for example, **Gross Value Added (GVA)** data from National Accounts reflecting changes in industry output **should not be included in CBA as it does not measure welfare**.

When it is difficult to directly estimate benefits it is, however, possible **to convert GVA into a proxy** for social welfare benefits by accounting for the opportunity cost of the resources used in production of goods and services. Therefore, **only a portion of GVA increase will be a welfare gain** (e.g., producer and labour surplus).

Note that this approach **cannot account for non-monetary welfare impacts** (i.e., externalities) either positive or negative, which need to be measured separately.

Undertaking this type of analysis may be helpful when estimating economic surplus, for example, predicting changes to existing or new business surplus or surpluses to industry from public investment. In some cases, the specific businesses impacted may not be known but the industry or industries expected to be affected by public investment is known or indicated.

Treasury should be consulted as specialist support is likely required to do this analysis.

Treatment of Commonwealth Government funding

NSW Government initiatives may receive funding from the Commonwealth Government. Commonwealth Government funding is provided to all states and territories for specific and general purposes. CBA considers the efficient use of resources to improve welfare, but two considerations are relevant for this issue:

- **Referent group**: CBA in this Guide includes resource costs and benefits to NSW residents only.
- **Base case**: Outcomes of an initiative are considered relative to the base case, hence should cause incremental changes to welfare.

If Commonwealth Government funding for an initiative would have been received by New South Wales in the base case (possibly for an alternative initiative), then it should be treated no differently to NSW funding. Investing the Commonwealth Government funding in this initiative has an opportunity cost equal to the full value of the funds. For example:

- funds disbursed under an established funding agreement or regular co-funding arrangement
- payments that will result in New South Wales receiving a lower share of GST, or a reduction in other untied grants.

If Commonwealth Government funding for an initiative will only be received in the case where that initiative proceeds, for example funds secured through a competitive grant application process, then the funding is an injection of resources into New South Wales relative to the base case. In this specific case, the Commonwealth Government funds are costless resources from a NSW perspective (i.e., investing the funds in that initiative carries no opportunity cost), so the value of the funds can be included in the CBA as an offset to the initiative's costs.

Note, submitting a project for Commonwealth Government funding that has a low BCR from an Australian perspective but high BCR from a NSW perspective could potentially reduce the likelihood of grant success. Further, it is not clear that the marginal cost of the Commonwealth Government funding has no impact on New South Wales, given New South Wales constitutes around a third of Australia.

For transparency, **sensitivity analysis treating the Commonwealth Government funding as NSW funding** is recommended to understand the difference in the results this treatment makes from a state versus national perspective.

A3.4 Carbon Emissions

Cost of carbon emissions

Human activities can increase carbon dioxide emissions, which have harmful effects on climate and affect third parties in a negative way. Third party costs on the referent group are included in CBA. **Potential climate change impacts should be assessed like any other risk factors** that affect the economic life cycle of assets, as part of an agency's ongoing risk management and decision making for both existing and new assets.

The cost of CO_2 emissions (and other emissions measured in CO_2 equivalent emissions), or the benefits of reduced CO_2 emissions, should be included in a CBA where the cost or benefit is likely to materially affect the NPV and BCR.

The creation of a carbon value is outside the scope of these guidelines. However, there are three common ways to value carbon emissions:

- **Social cost of carbon** (or damage costs) modelling quantifies the amount of damage caused by marginal additional emissions. The cost reflects the value of damage caused by allowing an extra unit of emission. This cost can be calculated to estimate the damage caused globally, or the damage to a particular jurisdiction.
- **Marginal abatement cost** modelling (i.e., a target consistent approach) estimates the marginal cost of reducing emissions along a trajectory necessary to reach a defined emissions reduction target in future.

- **Market prices** (effectively another form of target consistent approach) quantify the cost of carbon emissions within specific policy settings. Where a market is designed to achieve an emissions target (for example, through a cap-and-trade arrangement) the market will provide a value for the cost of abatement necessary to reach that target. This approach is less reliant on modelling assumptions, but its reliability is influenced by choices in market design.

The cost of negative externalities can effectively be quantified by reference to the damage caused by these externalities. By this reasoning, **damage costs** (such as from sea level rise, increased fires and flooding, and reduced productivity) most consistently reflect the approach taken to assessing externalities in a CBA. However, are several difficulties with a damage cost approach:

- There is no agreement on the modelling assumptions underlying a damage cost approach, and estimates produced and adopted in other jurisdictions vary widely.
- While justifiable due to international treaties recognised by the NSW Government, and the expectation of reciprocity, presenting costs as the global damage that would result from an action does not align with the concepts of standing used in other parts of NSW CBA guidelines.
- Internationally, jurisdictions appear to be moving towards the third approach (a **target consistent** approach).

A damage cost approach is therefore not preferred at this time.

Both the New South Wales and Federal Governments have adopted emissions reduction targets. However, at this time, neither level of Government has adopted a price for carbon emissions to achieve these targets. International examples of prices include:

- The World Bank and the Intergovernmental Panel on Climate Change within the United Nations have produced global abatement cost estimates.
- The European Union Emissions Trading System is the world's largest carbon market. While this market has specific design features that reflect jurisdictional factors, as of 2022, the prices of European Union carbon permits fall within the band of prices estimated by jurisdictions adopting social cost and abatement cost methodologies.

The following principles should guide the quantification of the cost of carbon emissions for a CBA:

- A comprehensive Australian emissions market would value carbon emissions consistently with Australian targets, abatement opportunities, and opportunity costs. Value would be revealed by market participants rather than through modelling assumptions. No such market is, however, currently in operation.
- In the absence of a reliable Australian market, a cost modelled in line with a target consistent approach, produced and adopted by the New South Wales or Commonwealth Government, should be used as a basis for valuing the costs of carbon emissions. Such a value estimate may be developed in the future as jurisdictions continue to develop their emissions policy.
- In the absence of the above, existing market prices from the market that most comprehensively prices emissions (e.g., the European Union carbon permit market) can be used as a proxy valuation. A CBA using carbon market prices should use an annual average price over the most recent complete calendar or financial year, in Australian dollars.

While these principles will allow appraisals to apply a carbon value that is consistent with these guidelines, **Treasury will provide supplementary guidance to improve consistency, see Technical Notes: Carbon emissions value for CBA guidance**. This guidance will set out a value that can be used for a stated period, and is expected to be updated semi-annually, or as new information becomes available.

If some value of carbon is already incorporated into market prices, then in principle, the cost of the externality is reduced to that extent. In many cases however, this may be impractical to quantify.

Scope of relevant emissions

The emissions impacts given standing in a CBA should include the emissions that occur within New South Wales. Each tonne of carbon that occurs in New South Wales should be counted **as a whole and not pro-rated by population or any other factor**. This approach is intended to be consistent with the concept of standing that is generally applied throughout this guide. It includes emissions directly produced or mitigated by a program, as well as the emission impacts from changes in behaviour within New South Wales that result from the program. This approach is also intended to be broadly consistent with the emissions taken into account for the reduction target that New South Wales has committed to, and which would be used in developing a target consistent price.

Examples of relevant impacts include:

- emissions from the combustion of fuels within New South Wales, whether as part of the program, for the purposes of generating electricity for the program, or by NSW residents as a result of the program
- emissions from the manufacture or disposal of products within New South Wales
- emissions arising from the use of NSW land.

Emissions from the use of products produced in New South Wales but consumed elsewhere, and emissions from materials or inputs sourced from outside of New South Wales would generally not be included in the CBA.

In practice, the origin of construction materials will generally be unknown at the time of the CBA. To ensure consistent practices, all CBAs are therefore required to make a technical assumption to include emissions arising from the use of construction materials (known as embodied emissions) regardless of where the materials are produced.

As emission reduction policies such as carbon markets develop, the prices of these products will adjust accordingly. Over time, this is likely to reduce the need to separately incorporate emissions values.

Escalation and sensitivity testing

Models of social costs of carbon and marginal abatement costs show an escalation of costs over time. This is also generally reflected in market futures prices. This is because of modelling assumptions around the amount of damage caused by additional emissions, and the depletion of the least costly abatement opportunities.

While escalation rates vary across different models and methodologies, typical annualised rate increases are in the order of 1.5 to 3 per cent. For simplicity, **carbon costs should be escalated at a rate of 2.25 per cent per year** in real terms unless reasonable arguments are presented for the use of a different escalation factor. The aforementioned **Technical Note** includes guidance on escalation to ensure that material new information can be incorporated as needed.

Sensitivity analysis is mandated in this Guide and should be applied to consider the implications of adopting a different carbon price. Appropriate prices to use for sensitivity testing includes damage cost or target-based estimates from major comparable jurisdictions (e.g., New Zealand, Canada) or international organisations (e.g., Intergovernmental Panel on Climate Change and/or World Bank). Where market prices are used, sensitivity may also consider the implications of using high or low market prices over a recent period. The impact of a zero price should also be tested for completeness.

A3.5 Items that should be excluded from CBA

Sunk Costs

All costs in a CBA relate to new (i.e., forward looking) expenditures incremental to the Base Case only. **All past or sunk costs should be excluded from the analysis**.

Depreciation

Depreciation is an accounting method that reflects the cost of consumption of capital over time. In CBA, capital costs should be included at the time of expenditure (representing the opportunity cost of resources used). **Depreciation should not be included as a cost in a CBA because this would double count capital costs**.

Interest

Interest costs are excluded from costs in a CBA. As future costs and benefits are discounted to present value terms, the discount rate already reflects the use of capital resources over time. Discounting converts a flow of future funds into an equivalent, up-front value. Including interest cost or dividend returns to equity would double count the cost of capital implicit in the discount rate.

A3.6 Transfer payments

Transfer payments

Transfer payments[45] are financial transfers between people or businesses within New South Wales. For example, a cash rebate paid from the Government to a resident. A transfer payment incurs a financial cost for the payer and an exactly equivalent financial benefit for the payee. Therefore, transfer payments on their own do not result in resource costs or benefits.

In general, transfer payments should be:

- **excluded from CBA results,** as they do not impact net benefits
- **included in distributional analysis**, see Appendix 5.2.

The presence of transfer payments can, however, complicate the calculation of **net benefits** for CBA. Generally, there are two approaches towards isolating net benefits in the presence of transfer payments:

- Directly comparing the total value of incremental benefits (typically valued through total willingness-to-pay) to the total value of incremental resource costs used to produce the benefits, or
- Calculating the net surplus received by each group (e.g., consumers, producers) after transfer payments have been made.

Box A3.5 illustrates these two approaches through a hypothetical numerical example.

45 Note: transfer payments here are an unrelated concept to 'benefit transfers'.

Box A3.5: Illustrative example of approaches to calculating net benefit

The government is providing a service to one consumer. For the service:

- the consumer is willing-to-pay $10 (i.e., they value the service at $10)
- the service costs $3 (in real resource costs) to provide
- the government is charging the consumer $6 to access the service.

The payment of $6 from the consumer to the Government is a transfer payment because it is not reflective of the economic cost of service provision. There are two approaches towards the calculation of the net benefit of the service; both provide the correct answer:

Direct approach:

- net benefit is equal to total WTP minus total resource cost
- net benefit = $10 – $3 = $7.

Surplus approach (also known as resource cost correction approach):

- net benefit is equal to the consumer's surplus plus the government's surplus
- consumer surplus is equal to WTP minus price paid
- government surplus is equal to price received minus resource cost.

Net benefit = ($10 - $6) + ($6 - $3) = $7.

Whichever approach is taken, the CBA needs to clearly identify where transfer payments have been quantified and analysts should take care to avoid either double-counting or under-counting benefits in the presence of transfer payments.

Treatment of grants and vouchers

Some initiatives involve the government making a direct financial payment to households, businesses, local councils, or non-government organisations to achieve a policy outcome. For example, grants to businesses to conduct research and development or vouchers distributed to households to fund activities like children's co-curriculars.

For CBA of these types of initiatives, the financial cost of the payments made by the government should be included in the CBA result as a resource cost (because they have an opportunity cost of not being invested elsewhere).

The financial payment received by the recipient should be included in the CBA as a benefit. The size of the benefit for the recipient will depend on how they are expected to (or are allowed to) spend their payment.

For example, an unconditional financial payment could be assumed to have benefits to the recipient exactly equal to the size of the payment. A payment that is tied to certain conditions (e.g., can only be spent on certain things), however, may be valued by the recipient at less than the financial value of the payment.

Treatment of taxes and subsidies

Taxes (and subsidies) are transfer payments[46] which increase (or reduce) the prices faced by producers and consumers. Generally, the payment of taxes and subsidies should be excluded from economic costs because they do not represent a resource cost.

Taxes may be included in WTP valuations when they form part of the price a consumer is willing to pay for something. Indirect taxes on inputs (e.g., GST) such as construction costs and taxes on profits (producer surplus) are usually excluded from CBA.

The impact, and therefore CBA treatment, of taxes and subsidies will depend on the **balance between additional effects** (i.e., net increases in output attributable to the initiative) **and displacement effects of the initiative** (i.e., increases in output displacing other output that would be produced).

Box A3.6 below summarises various taxation mechanisms and associated treatments in a CBA, with New South Wales as the referent group.

Box A3.6: Summary of tax treatments in CBA from initiatives generating additional revenue

State Government taxes (e.g., Payroll tax, land tax and stamp duty etc.)

- **From NSW entities**: Generally, NSW taxation revenue paid by NSW entities is a transfer payment. In cases where an initiative generates additional economic activity (relative to the base case) that results in incremental changes to taxation revenue, taxes should be accounted for similarly to other transfer payments using one of the two approaches illustrated in Box A3.5.
- **From non-NSW entities**: If an initiative generates additional economic activity (relative to the base case) that results in additional NSW taxation revenue being paid by non-NSW entities, then this revenue represents an injection of funds into New South Wales and therefore may be a benefit in the CBA.

Local Government taxes

- **Council rates**: Levied by Local Government on property owners. If council rates are relevant to a CBA, they should be treated in the same way as NSW taxes.

Commonwealth Government taxes

- The impact on New South Wales of additional tax revenue paid to the Commonwealth Government cannot be estimated accurately. **Generally**, this revenue is considered to not accrue to the NSW referent group and therefore not represent benefits in CBA.
- For practical purposes, surpluses in CBA should be undertaken on a pre-income tax basis (personal and corporate income tax).
- **Goods and services tax (GST)**: GST is collected by the Commonwealth Government but re-distributed directly to the states and territories. Therefore, part of each dollar of additional GST raised in Australia is received directly by New South Wales. For practical purposes, CBA should assume that New South Wales receives 32 per cent of additional GST revenue (roughly equal to New South Wales' share of Australia's population) raised as a result of an initiative.

46 Taxation takes part of the income of private parties and transfers it to a government, which in turn pays subsidies (welfare benefits or concessions) or provides goods and services to private parties. Those who pay the tax are not necessarily the same parties who receive the benefits.

Excess burden of taxation

Revenue from taxation provides the majority of government funds, hence government's initiatives are usually considered to be funded by taxpayers. The cost of general taxation is the deadweight loss (or excess burden) to society from distortions to resource allocation that lead to a loss of welfare. For example, payroll tax thresholds could lead to reduced incentives for businesses to grow as they are only required to pay payroll tax above a given level of total wage payments. Collecting taxes also carries administration and compliance costs.

From the perspective of CBA, Government funds are usually raised in advance of an approval. Because CBA is forward-looking, unless there is a change in taxation arrangements attached to the initiative, then total deadweight loss will be the same going forwards (i.e., taxation arrangements will be the same) between the base case and option case.[47]

Consequently, this Guide recommends that **the excess burden of taxation does not need to be reported in the central CBA result or sensitivity analysis, unless requested by Treasury**.

For initiatives involving changes to taxation arrangements (e.g., a new or revised tax or change in tax rate), deadweight loss from taxation itself is the major consideration in the CBA and hence is required in the analysis.

A3.7 Additionality, Displacement, and Leakages

The volume and valuation parameters in CBA modelling should properly consider marginal impacts and incremental analysis. Non-NSW entities may also be impacted by an initiative. Estimating benefits to the NSW referent group therefore requires consideration of **additionality**, **displacement,** and **leakages**.

Additionality

Additionality is a concept used to account for net increases in benefits, that is, an increase in benefits to the referent group with the initiative relative to the base case. Consideration of the base case is essential to determine true additionality.

Displacement

Displacement occurs when another activity is 'crowded out', relocated, or partially reduced somewhere else in New South Wales, e.g., where a supported NSW business takes market share away from an unsupported NSW business. Displacement can affect producers, consumers, and labour. Crowding out may be less likely when an initiative impacts a tradeable sector of the economy (i.e., a sector with a significant proportion of imports or exports) rather than local sectors that service a smaller community. Crowding out is more likely to occur when the economy is close to full capacity or unemployment is low, and less likely when there is spare capacity.

Leakages

Leakage is the extent to which benefits generated in New South Wales 'leak out' to other jurisdictions. For example, consider a business operating in New South Wales but owned predominately by overseas shareholders. Profits that are generated in New South Wales by this

47 Mishan EJ and Quah E (2021) Cost-Benefit Analysis, 6th ed. Routledge, 167, describe the excess burden concept as something of 'a green mare's nest' and do not advocate for its inclusion when considering how an initiative is financed. This view is not universally held in other textbooks (e.g. Boardman et al 2018) and similarly in official guidance (e.g. the HM Green Book excludes DWL, but the OMB Circular A-94 Guidelines and discount rates for benefit-cost analysis of Federal programs requires supplementary analysis with a 25 per cent excess burden).

business accrue to or leak out to the overseas owners, rather than to the NSW community. This type of leakage is excluded as a benefit from the CBA.

Appendix 4: Dealing with uncertainty in CBA

All initiatives are subject to risk and uncertainty to different degrees. This appendix explains:

- the difference between risk and uncertainty
- why risk and uncertainty need to be accounted for to produce an accurate BCR
- methods for accounting for risk and uncertainty and producing a probabilistic CBA result — focusing on the use of Monte Carlo Analysis.

Monte Carlo Analysis may initially seem complex, but its undertaking is increasingly approachable and feasible. Appropriate use of Monte Carlo Analysis can move a CBA closer to best practice.

Real Options Analysis can be a valuable supplement to Monte Carlo Analysis — offering the potential to alter the scope or timing of an initiative so it is less exposed to downside risks and more exposed to upside risks.

A4.1 Concepts of risk and uncertainty

Difference between risk and uncertainty

Risk and uncertainty can have different meanings. A common distinction is whether possible future events can be objectively quantified using historical observations.

Risk occurs when probabilities can be assigned to uncertain future events. These probabilities can be either assigned objectively, based on historical observations, or can be based on subjective probabilities where historical data is not available or applicable.[48] **Risk is therefore quantifiable.**

Most costs and benefits in *ex ante* CBA will be associated with some degree of risk, as predicting the future is inherently uncertain. Risk can fall into several categories, such as those that:

- are manageable or open to mitigation
- have a very low probability of occurring but incur a very high cost if they eventuate ('catastrophic' events)
- have relatively manageable costs but a relatively high probability of occurring.

Uncertainty occurs when probabilities cannot be reasonably assigned to possible future events. **Uncertainty is therefore unquantifiable.**

For example, predicting technological change may be impacted by uncertainty, as we anticipate technological change will happen, but we cannot predict what it will be or assign a probability to different paths of technological change.

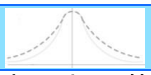
Uncertain events like technological change are outside the initiative team's control and could change outcomes or even fundamental assumptions that underpin a service need, if the 'future state' could be different to that assumed during the proposal development.

'Knowns' and 'unknowns'

Risk and uncertainty can be described with reference to what is known and what is unknown. Table A4.1 below presents combinations of 'knowns' and 'unknowns' along with methods that can account for risk and uncertainty in each situation.

48 Subjective probabilities is a type of probability derived from an individual's judgement or own experience about whether a specific outcome is likely to occur.

Table A4.1. Knightian Matrix of knowns and unknowns

Known Unknowns 	Known Knowns 
Risks and distributions are known and can be estimated but not with certainty about the range of possible outcomes as the extent to which these risks will materialise and the way that it may impact an initiative is unknown. These issues are known as 'model uncertainty' or 'parameter uncertainty' and can be addressed through ongoing improvement processes to models, such as the testing and calibration of forecasting models, and reference class forecasting. Example: for many initiatives, proponents know that there is a risk of flood, wildfire, cost overrun, patronage shortfalls, or climate risks, but we are uncertain of their severity, frequency, and timing. Floods and cost overruns may follow an estimated 'fat tail' distribution but occur more frequently and severely than estimated. This challenge can arise from data limitations but also because the risks are hidden in low-frequency high-consequence events known as 'tail events'. **To help manage 'known unknowns' proponents can test the sensitivity of assumptions about risks (relevant to the project) through Monte Carlo analysis but also scenario analysis to understand what happens to an initiative if a risk is not quantified accurately.**	**It is possible to know the risks and probabilities, and to estimate the full distribution of possible outcomes with certainty — over repeated rounds the expected values of outcomes are known and consistent.** The absence of uncertainty is a feature of dice games, where the value of the dice create certainty about the full range of possible outcomes and their likelihoods. Two dice can produce only real numbers between 2 and 12: creating upper and lower bounds for outcomes. The distributions of values within these bounds also follow a non-random process (for a large number of rolls). This certainty about the range of possible outcomes and their distribution is not possible when estimating natural disaster risk as it is impossible to know with certainty what the largest flood, earthquake, or storm event may be, or even what the magnitude of 1-in-500-year or 1-in-1000-year event is. In these 'open systems' we can only produce estimates subject to uncertainty. Example: quantity surveys for off-the-shelf non-bespoke or highly standardised products. Expected value measures are useful but also need the full distribution of possible outcomes. **To deal with 'known knowns' proponents can develop probabilistic CBAs using Monte Carlo Analysis that present the full range of possible outcomes.**
Unknown Unknowns 	**Unknown Knowns** 
The risks and unknowns and distributions cannot be estimated accurately as they are subject to developments outside of what can be formalised accurately in models, due to 'Black Swan' or 'White swan' events. Uncertainty plays a dominant role as it could change all expected outcomes for better or worse. While the source of uncertainty cannot be identified, it is possible to identify exposure to types of uncertainty, especially events that are low-frequency(rare) but high-impact and provide optionality to respond to such events. Example: while it may not be possible to know all the reasons why a business may need to require employees to work from home for 12 months (a set of 'unknowns') it is possible to know the ICT systems and management arrangements required to facilitate prolong working from home. Allowing mangers to rollout video meeting software, move ICT systems to the cloud, and make other arrangements necessary for employees to access critical systems remotely. **A combination of Monte Carlo Analysis and real options analysis can be very useful for insuring a project against 'unknown unknowns' — identifying the exposure of an initiative to future changes and altering the scope of timing of the initiative to manage this exposure.**	**These are risks that are known but which become 'unknown' because they are forgotten or receive insufficient attention — meaning that they are not reflected adequately in a CBA.** These risks are referred to as 'risks you were supposed to know but it turns out that you did not know' due to some oversight or error such as: 'planning fallacy', climate risk, the presence of sublimes, or 'Optimism Bias'. These oversights can include cognitive biases but also other challenges humans face in appreciating the role of randomness. We become unconsciously blind to uncertainty as it is difficult to comprehend. So extra attention is needed to ensure that all risks are identified and accounted for. Example: the distribution of outcomes in cost estimates can differ from that observed in reality: underestimating the probability and consequence of overruns due to optimism bias, planning fallacy, or the presence of 'sublimes' — such as the 'technological sublime' or 'aesthetic sublime'. **To avoid 'unknown knowns' proponents can work to identify all risks that may impact an initiative and test an initiatives exposure to these risks — ideally through Monte Carlo Analysis.**

A4.2 Accounting for risk and uncertainty in CBA results

CBA results should be based on expected values

Central CBA results, NPV and BCR, should generally be based on expected values (averages). Ideally, expected values will be calculated from a full probability distribution of possible outcomes, such as the distribution estimated by Monte Carlo Analysis. The expected value is the probability-weighted average of all outcomes in the distribution.

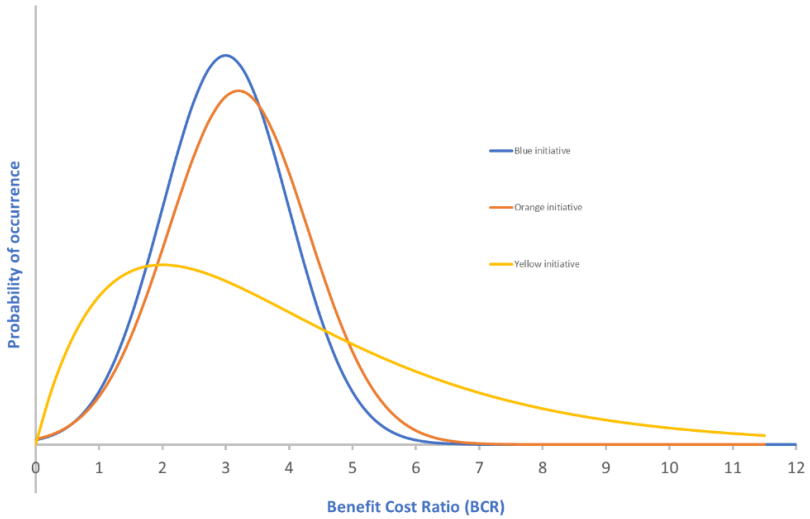
Where full probabilities are available, analysts are encouraged to consider using Monte Carlo Analysis, which is increasingly being incorporated as routine in CBAs to estimate expected value with greater precision. Monte Carlo Analysis is relatively low-cost and can be applied quickly.

In cases where estimating a full probability distribution is not feasible, simplified distributions can be used to derive expected values. For example, generating a 'three-point estimate' comprising a worst-case, most likely outcome and best-case with probability weights based on expert opinion, or taking a midpoint of several estimates.

Accounting for risk and uncertainty is important to give a complete picture of CBA results

NPV and BCR results alone will not necessarily reflect the different risks and uncertainties faced by initiatives. It is possible for initiatives to have the same or similar central NPV and BCR result but very different distributions of possible outcomes. Figure A4.1 provides an illustrative example.

Figure A4.1. Illustrative example of probability density functions of BCR results for three hypothetical initiatives



The three hypothetical initiatives presented in Figure A4.1 have near-identical expected values for BCR but very different exposure to upside and downside risk. Looking at the expected BCR only would obscure the relatively low downside and high potential upside of the 'Yellow' initiative, which a decision-maker managing risk across a portfolio of initiatives may prefer to the risk profile of the 'Blue' or 'Orange' initiatives.

Accounting for risk and uncertainty in CBA is also critical for initiatives dealing with potentially catastrophic events such as natural disasters. Catastrophic events may have a very low probability of occurring in any single year but cause devastating losses if they occur with no mitigation measures in place.

Consequently, looking only at the central NPV and BCR of mitigation measures for catastrophic events may obscure their potential value to the community at risk. For these measures, it is important to present the full distribution of outcomes alongside the NPV and BCR.

Cost estimates from probability distributions

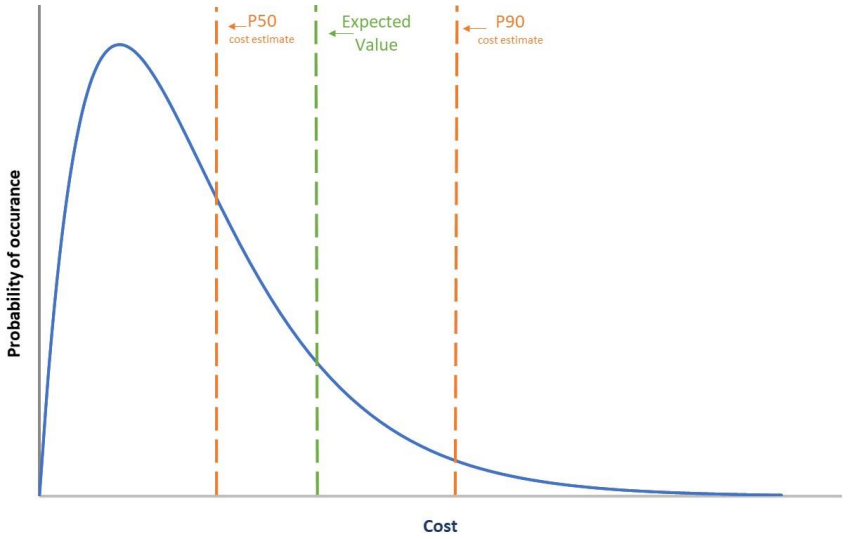
Cost estimates, usually for infrastructure initiatives, can be generated from a probability distribution of possible outcomes. This is a common use-case for Monte Carlo Analysis.

Probabilistic cost estimates will often report the median value, referred to as the 'P50 estimate' because there is a 50 per cent chance of the actual cost being equal to or lower than the P50

estimate. Similarly, a 'P90 estimate' can be produced, where there is a 90 per cent chance of the actual cost being equal to or lower than the P90 estimate.

For a symmetrical, normally distributed probability distribution, the median value and expected value will coincide. However, they will differ for a skewed or non-normal distribution. For a distribution skewed towards cost overruns, as depicted in Figure A4.2, the expected value will be higher than the median (and likely lower than P90).

Figure A2.2 Simple example of a probability cost distribution curve



A4.3 Methods for accounting for risk and uncertainty in CBA

Sensitivity analysis shows how CBA results vary with changes in assumptions or parameters. It illustrates what could happen to costs and benefits if the assumptions made about some or all key variables prove to be different from central expectations.[49]

Testing the robustness of CBA results to changes in key parameter values provides crucial information for decision makers. In some cases, the results of sensitivity analysis could lead to a recommendation that varies from simply prioritising the option with highest NPV.

There are several methods for undertaking sensitivity analysis, this section discusses:

- Simple parameter testing
- Expected Net Present Value (ENPV)
- Monte Carlo Analysis
- Scenario planning

Simple parameter testing

Sensitivity analysis can be undertaken by varying a single parameter (or benefit category), holding all others constant. Parameter testing should be tailored to the initiative, focusing on the key parameters or scenarios with material impacts on the reported benefits and costs.

49 See: https://www.pannelldiscussions.net/2008/06/126-sensitivity-analysis-with-economic-models/ for a discussion on simple system to undertake sensitivity analysis.

The risk profile and key risk drivers for the initiative are a useful starting point for identifying parameters to test. In some cases, sensitivity analysis could test the application of alternative forecasting or valuation approaches.

Important relationships between cost and benefit drivers should be considered. It may be appropriate for the sensitivity analysis to **include scenarios where multiple key parameters are varied in the same direction (that is, worst-case and best-case analysis)**.

This type of sensitivity analysis is most informative when central NPV results are positive (for worst-case analysis) and negative (for best-case analysis), respectively. Note, the probability of realising these extreme results may decrease as more parameters are varied.

Undertaking only a standardised sensitivity analysis on total costs and benefits (e.g., plus 20 per cent and minus 20 per cent to total costs or benefits) **is generally not recommended**. However, this it may be helpful in the early, less detailed stages of CBA.

Expected Net Present Value (ENPV) through simple risk weightings

Calculating Expected Net Present Value (ENPV) through simple risk weightings is a simple and practical approach to incorporating risk into CBA. It may be suitable when it is difficult to differentiate between two initiatives or options with similar central NPV estimates.

Estimating ENPV requires **defining a set of discrete potential events and assigning a probability of each event occurring**. The ENPV of the initiative is then calculated by multiplying the NPV for the initiative under each event by the estimated probability of the event occurring and then summing the result.

The estimated probability of each event occurring can be determined based on historical data, some related experience, expert opinion, or other sources of information. The source for probability estimates should be clearly documented in the CBA report.

Considering risk in Expected Net Present Value (ENPV)

CBA assumes risk neutrality.[50] However, the probabilities used to determine ENPV can provide additional information to decision makers by revealing the uncertainty of cost and benefit streams.

For example, Table A4.2 presents Project A, which has a 70 per cent probability of producing an NPV of $1.0 million and a 30 per cent probability of producing an NPV of $2.0 million. The ENPV of Project A is therefore $1.3 million. Project B has a 50 per cent probability of producing an NPV of $1.25 million and a 50 per cent probability of producing an NPV of $1.35 million. The ENPV of Project B is therefore also $1.3 million.

Table A4.28. Illustration of simple risk weighting

Policy options	(1) NPV Result (Event 1) ($m)	(2) Probability of Event 1	(3) PV Result (Event 2) ($m)	(4) Probability of Event 2	Risk weighted ENPV = (1)x(2) + (3)x(4)
Project A	1.00	0.7	2.00	0.3	1.3
Project B	1.25	0.5	1.35	0.5	1.3

Table A4.2 shows that Project A and B have the same ENPV, but Project A is relatively riskier because it has a wider range of possible outcomes.[51] There is a high chance of Project A returning an

50 Risk neutrality is where a person is indifferent between a certain outcome, and a gamble with the same expected value.

51 More generally the degree of risk is reflected in statistical measures such as the standard deviation and confidence interval.

NPV of $1 million, which is lower than any outcome of Project B. This demonstrates the importance of presenting information on the probability distribution used to determine the ENPV.

For CBA of smaller initiatives, ENPV based on a simple risk weighting of a few expected outcomes (e.g., worst-case and best-case, along with the central estimate), usually based on experience, may suffice. For more complex CBA, consideration of the probability distribution function used to calculate the ENPV for each option may contain important information for decision makers.

Monte Carlo Analysis — creating probabilistic cost-benefit analysis

Monte Carlo analysis is a computerised simulation based on repeated random sampling from relevant probability distributions (assigned based on historical data or judgement) to produce multiple simulations. These simulations are used to derive a combined frequency distribution of certain outcomes occurring. The number of simulations required to generate a well-defined distribution depends on the particular circumstances.

Simple parameter testing and testing worst-case and best-case scenarios has limitations. For example, these techniques do not account for the probability of each outcome for a parameter occurring. Monte Carlo Analysis is becoming more common in CBA to estimate the expected value of an initiative with greater precision.

Key parameters in a CBA may each have their own probability distribution. Monte Carlo Analysis can be used to combine multiple probability distributions to produce a probabilistic overall CBA result.

Monte Carlo simulations facilitate the analysis of risks from a combination of varying assumptions and probability distributions. In principle, any number of risks or causes of uncertainty relating to an initiative could be included. This could include scenarios where these risks may occur individually, sequentially, or simultaneously. Examples of salient risks that have been incorporated in costs and benefits using Monte Carlo analysis in a high-cost or complex proposal includes:

- site risks (e.g., contamination and remediation)
- design, construction, and commissioning risk
- financial risk
- operating risk
- tax and other legislative changes
- market risk and general economic conditions
- network and interface risk
- regulatory risk
- force majeure
- breach, default and/or termination risk
- rainfall scenarios.

As another example, the frequency and severity of floods or wildfires in a model may underpredict what is observed due to omission of empirical evidence held by First Nations people and communities or omission of climate risks. To address such ‘unknown knowns’ (see Table A4.1), proponents can work to identify all risks that may impact an initiative and test the initiative’s exposure to these risks, ideally through Monte Carlo Analysis.

Monte Carlo Analysis can generate probability distributions for the NPV and BCR. These can then be used to determine an expected (average) NPV and BCR and the probability that the NPV will be positive or that the BCR will exceed a certain value. This allows for the application of confidence

intervals. For example, if the lower bound of a 90 per cent confidence interval for the BCR is equal to 1.0, then we can be confident the BCR will be above 1.0, 95 per cent of the time.

Monte Carlo Analysis only provides a realistic distribution of outcomes if the assumptions and data underpinning the analysis are accurate and realistic and the appropriate distribution is modelled.

Probabilistic modelling approaches should be informed by research, learnings from similar projects and experts' opinion on appropriate values of input variables. Experts can include project managers, service delivery officers, legal or other experts who are able to identify the relevant probabilities.

Box A4.1 describes the use of Monte Carlo Analysis in CBA of water supply initiatives.

Box A4.1: The role of Monte Carlo Analysis in understanding the impacts of water supply initiatives

One of the most significant challenges in CBA of initiatives for managing water supply is the significant uncertainty about future rainfall and what this means for an initiative's benefits profile.

For example, once a drought begins, there is uncertainty over how long it will last. Investing in additional water supply, say by building a desalination plant, may produce very high benefits if the drought is ongoing when the plant is finished, but relatively little benefit if the drought ends before the plant is operational.

A Monte Carlo Analysis could incorporate the uncertainty about future rain into the CBA by randomly generating thousands of different possible rainfall scenarios over a 100-year period.

The results of the Monte Carlo Analysis can then be used to produce a probabilistic CBA, based on the benefits of the initiative under each rainfall scenario.

Box A4.2 provides useful resources on Monte Carlo simulation.

Box A4.2: Resources on Monte Carlo Analysis

- European Commission, Guide to Cost-Benefit Analysis of Investment Projects (2014). See Annex III pp 337-342 for an introduction to Monte Carlo simulations including case studies.
- Boardman et al, Cost-Benefit Analysis: Concepts and Practice, 5th Ed., Appendix 11A.
- ATAP, Risk and uncertainty assessment (2021). Provides a detailed explanation of undertaking probabilistic CBA, with examples.
- Australian Government, Department of Infrastructure and Regional Development's supplementary guidance Probabilistic Contingency Estimation. Provides in-depth discussion and a worked example related to an infrastructure project.

Scenario planning

Scenario planning sets up a few plausible scenarios to test key technical, economic, political, or other uncertainties that could affect the success of an initiative. Scenarios usually consist of future states that differ in crucial respects, usually significant or 'big picture' factors. Each scenario must be internally consistent and independent of the other scenarios.

Scenario planning is best undertaken in conjunction with (or considering the assumptions tested in) parameter sensitivity analysis. **Sensitivity analysis on parameters occurs in the most likely state of the world, whereas scenario planning explores different states of the world**.

Scenarios are not forecasts; they describe 'what if' situations that might occur over the medium to long-term. For example (*illustrative only*), possible disruptions on account of different climate change scenarios, population growth scenarios, or travel behaviours (e.g., historical travel patterns or post-COVID travel patterns). Since they are not intended to be forecasts, scenario construction should avoid averaging scenarios or attempting to assign probabilities to scenarios or choose the most likely scenario.

In some cases, scenario planning can help to illuminate inherent uncertainty facing decision makers and support flexibility in planning to avoid locking in irreversible decisions prematurely.

Scenario planning is also a preparatory step when undertaking Real Options Analysis.

A4.4 Real Options Analysis

Real Options Analysis (ROA) is a valuable technique for ensuring that the scope and timing of an initiative provides the best chance of limiting its exposure to downside risk while increasing its exposure to upside risk by creating 'optionality' within an initiative, as well as improving design.

Real Options (ROs) provide the flexibility, but not the obligation, to undertake certain actions in the future, or to alter a project pathway when risks and uncertainty become clearer. ROs create the option to make the initiative more suitable to future states of the world.

For example, if an initiative is exposed to cost escalation through increased input costs, proponents can manage this risk by creating the RO to substitute into less-expensive substitute inputs (where possible) or delay the project until the risk of cost escalation has subsided.

ROA recognises the potential benefits of flexibility and optionality in investment strategies, allowing initiatives to be updated, changed, or even abandoned as new information becomes available.

ROs can be defined in advance and include clear trigger points that determine when the opportunity to execute the real option arises. Table A4.3 contains several examples of ROs.

ROA aims to **estimate the dollar value of keeping options open which might otherwise be closed off based on initial NPV assessment for the most likely outcome**. In some cases, this means postponing investment decisions until trends in demand or cost risk become clearer.

In some cases, ROA may suggest, for example, choosing to forego some economies of scale by constructing a smaller project with the option of expanding it under certain growth outcomes. Box A4.4 provides an example in decision-tree form.

It is recommended that ROA is considered for:

- Long-lived infrastructure initiatives. For example, a real option for a road initiative could be to set aside additional land adjoining the road. If required in the future, the additional space can be used to widen the road as demand increases.
- Initiatives where there is a high degree of uncertainty over future payoffs from the investment. For example, water supply projects where there is variability in future rainfall or climate adaptation projects, where there is a large degree of uncertainty around climate forecasts.
- Initiatives where there is the ability or opportunity to delay the timing of the investment, at least partially.
- Initiatives where more information about potential rewards or payoffs (though never complete certainty) becomes available over time.

Table A4.39. Type of Real Options

Type	Examples
Timing options	Delaying an initiative or staging parts of the investment until there is more certainty around key assumptions. This may also include an option that allows investment to be deferred without giving up the right to invest in the project.
Staging options	Undertaking an initiative in stages as new information becomes more certain (such as demand forecasts or population growth). For example, building the foundations now that allow the ability to expand or reduce capacity in the future.
Switching options	Switching inputs or outputs to suit changes in demand and supply. In cases where prices or demand changes, the initiative has the flexibility to change the mix of inputs used to produce the same output.
Abandon options	An option to abandon allows proponents to exit the project during delivery for a pre-determined price on the basis that the poor results of the prototype indicate likely project failure.
Design option	Designing an initiative in a way that increases flexibility to respond to future service needs.

Incorporating Real Option Analysis into Cost-Benefit Analysis

Real option valuation techniques utilise statistical approaches to value real options and incorporate the results into a CBA. This approach may require costly technical expertise.

For practical purposes, real option *valuation* is likely to only benefit initiatives that are large scale, potentially irreversible, costly to revise during implementation and affected by significant uncertainty.

However, strategic real option *thinking* can be valuable for any project (see Box A4.3).

Box A4.3: Strategic real option thinking

Explicitly understanding and addressing uncertainties in the decision-making process and initiative lifecycle is the key principle of real options analysis. That is, under uncertain conditions, what is the best way forward that will maximise welfare now and into the future given the possibility of deferring some aspects of a project?

In this way, real option thinking should be considered in all projects, including unquantifiable uncertainty, when developing a range of options to address a problem or opportunity.

Decision tree analysis is a useful technique to consider possible decision points and quantify the value of any associated feasible ROs in CBA.

Decision tree analysis assists in analysing sequential risks compounding over time. Practitioners should know, with reasonable evidence, the key uncertainties or risks that result in a different 'future states', and estimate the probabilities of those future states occurring, and corresponding different options and pay-offs under various future states. Probabilities can be either subjective or objective depending on data availability.

This information can be visually mapped in a decision tree. See Box A4.4 for an example. The expected NPV for each branch of the decision tree can be calculated. The initial pathway that offers the choice of options that maximises the expected NPV is preferred.

Further, the actual project pathway followed may end up being different to the least cost pathway that would have been chosen in the absence of uncertainty.

Table A4.4 provides a list of resources on how to apply or review ROA.

Table A4.4: Resources on Real Options Analysis

Resource	Description and links
Infrastructure Australia Assessment Framework 2021 Guide to risk and uncertainty analysis	A technical supplement to Infrastructure Australia's Assessment Framework.
Department of Treasury and Finance (Victoria): Investing under uncertainty. Real options analysis technical supplement – Investment Lifecycle and High Value High Risk Guidelines	A technical supplement to Victoria's Department of Treasury and Finance (DTF), business case guidelines.
Australian Transport Assessment and Planning (ATAP) Guidelines, T8 Real Options Assessment	This guide provides a high-level overview of real options assessment and illustrates its use in transport assessment.

Box A4.4: Example of decision tree analysis for real options in a water supply infrastructure initiative

A proposal for investing in additional water supply capacity, such as dams, water towers, and desalination plants is being considered. There are two options to consider in one part of the water network:

- Option 1: invest in the construction of a standard dam now, or
- Option 2: invest in the groundworks and foundations for a dam which can be upgraded quickly in the future.

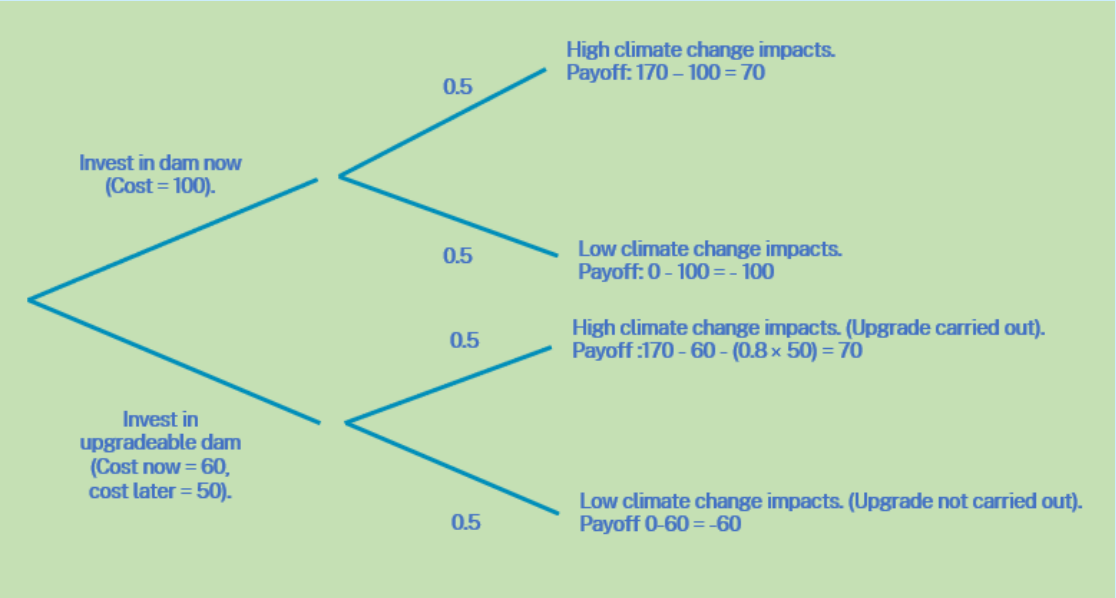
The decision to invest is required immediately to align to other projects in a network of broader infrastructure. There is an equal probability of high or low climate change impacts in the future.

The standard dam costs 100 and has benefits of 170 from avoided flooding if high climate change impacts occur (zero otherwise).

The groundworks for the upgradeable dam cost 60, the future upgrade costs 50, and the benefit is also 170 if high climate change impacts occur. The upgrade can be put off until there is more certainty about the impacts of climate change.

This information is set out in a decision tree:

Box A4.4 continued: Example of decision tree analysis for real options in a water supply infrastructure initiative



Simplifying assumptions: residual damages under the 'do not invest' strategies have been ignored; the discount factor for the future decision to upgrade or not is 0.8.

The expected NPV of investing in the standard dam is (0.5 × 70) + (0.5 × -100) = -15. This suggests the investment should not proceed.

Flexibility over the investment decision in Option 2 allows the possibility to upgrade in the future if the impacts of climate change are observed to be high. The expected value of this option can be calculated.

If the impacts of climate change turn out to be high enough to warrant upgrading, then the NPV of the investment is 70. If low climate change impacts eventuate, no upgrade is carried out, but the earlier groundworks are sunk costs, totalling 60. However, these sunk costs are lower than in the case of the 'standard' dam and overall, the expected NPV of investing now with the option to upgrade in the future is (0.5 × 70) + (0.5 × −60) = +5.

Comparing the two approaches shows an NPV of -15 for the standard approach, and +5 for the Real Options approach. The Real Options approach also has a non-monetised benefit because it allows better views of the dammed river for longer. The value of flexibility to upgrade in the future is reflected in the higher expected NPV and switches the investment decision.

Source: Adapted from UK Treasury's, The Green Book Central Government Guidance on Appraisal and Evaluation, Version 3 (2022).

Appendix 5: Social welfare and distributional analysis

This appendix outlines the basic theory of welfare economics and steps for undertaking distributional analysis that can inform equity considerations.

- Cost-benefit analysis estimates net social benefit, which is the difference between total benefits and total costs.
- In some cases, where the costs are borne by less well-off groups in society and the benefits accrue to better-off groups, an initiative with positive net social benefit may result in adverse equity outcomes.
- Distributional analysis disaggregates the overall impacts of the options by groups of beneficiaries. This transparency is valuable for decision makers to make informed decisions accounting for social equity as well as overall net social benefit.
- Illustrative examples of distributional analysis include the Kaldor-Hicks Tableau framework that provides an approach to identify the flow of benefits and costs between different sections of society.

A5.1 Social welfare

Social welfare depends on the accrual of benefits and costs to different groups in society resulting from economic activity. The key groups in welfare economics are:

- consumers
- producers (owners of land and capital)
- labour
- government[52]
- externalities
- environment.[53]

The sum of an initiative's benefits and costs on these groups is the **net social benefit**.[54] CBA estimates the net social benefit of an initiative by comparing the net benefit to all groups generated by the initiative relative to the base case (in present value terms).

It is useful for decision makers to understand the likely distributional impacts of proposed initiatives as in some cases the net social benefit of an initiative is positive, but some groups bear the costs. Decision makers may wish to structure the initiative to ensure that those that gain could compensate those that are made worse off.

In theory, if this compensation occurred then some people would gain, and no one would be worse off. In practice, negative impacts can often be ameliorated. It is therefore important for **decision-**

52 For example, see Richard J, Hueth D and Schmitz A (2008) *Applied welfare economics*, Edward Elgar Publishing.

53 Note: in this edition of the Guide, we have added Externalities and separately the Environment as additional key groups. Although externalities, including traditionally environmental externalities, are impacts on third parties as a result of production or consumption usually in primary markets.

54 Use of net social benefit is consistent with the first and second fundamental theorem of welfare economics. For a discussion of these theorems, See Abelson P (2018) 'Chapter 3: competitive markets: efficiency and welfare', *Economics: Principles and Practice*, On-Line edition.

makers to be advised on distribution of costs and benefits upon certain groups. Accordingly, CBAs are required to present an assessment of distributional impacts alongside cost-benefit results. In some cases, this analysis could identify options for compensation arrangements.

A5.2 Distributional analysis

Distributional analysis disaggregates the overall impacts of each option in a CBA by stakeholder groups, identifying those that gain and those that suffer losses or how gains are distributed across groups.

Distribution of gains and losses is an important aspect of any new initiative, particularly in a reform context. The success of some reforms can hinge on having a robust understanding of the distributional impacts as well as appropriate strategies to manage the distribution of gains and losses. Distributional analysis is likely to differ for each initiative, given the wide range of policies that could be developed and assessed by CBA. Potential categories, subject to data availability, are outlined in Table A5.1.

Table A5.1: Distributional analysis by category type

Category	Examples
Geographic regions	ABS Statistical Areas, Local Government Areas, planning regions, districts, metropolitan and regional New South Wales.
User type	Existing and induced (new) users of a service.
Income	Income quantiles or other specified ranges.
Institutional sectors	Households, businesses and Government.
Demographics	Age, ethnicity, gender, occupation.

The time and resources spent producing the distributional analysis should be **proportional to the size, risk and distributional impact of the initiative**. Greater levels of disaggregation are likely to involve greater analytical effort. The main consideration for analysts is whether some level of stakeholder disaggregation should be attempted and provided, and the consequence of potential outcomes to members of the community.

Factors that may inform this judgement could include, availability of data, the likelihood of losses to an identifiable group(s) and quantum of these losses, and existence of government financial transfers between groups (especially if they exacerbate income inequality).

Based on consideration of these factors and their effect on identified groups**, qualitative distributional analysis informed by evidence may be sufficient. Quantitative distributional analysis should be considered where effects are expected to be material** for the identified groups.[55]

Five main steps in a distributional analysis

1. Identify the key groups of interest in the relevant community for the initiative. For each key group, use project information or intended outcomes of policy design to determine appropriate sub-groups.

55 HM Treasury (2022) The Green Book – Central Government Guidance on Appraisal and Evaluation.

2. Allocate all category of costs and benefits identified in the CBA to each specific group where they apply.[56] Consider whether any of these costs or benefits may shift to another group. For example:
    a. savings in production costs may be passed on to consumers in lower prices (especially in a competitive market)
    b. where producers retain surpluses, these may accrue to owners of capital or to other employees
    c. user benefits (time savings) from transport infrastructure may (ultimately) be capitalised into land value uplift and accrue to landowners (rental returns)
    d. these shifts may be informed by various exercises including detailed modelling, outcome attribution in the logic model, ex-post evaluation information, or expected allocation of funding across sub-groups.
3. Consider how financial transfers are borne between groups, for example:
    a. taxes on producers may be passed on in higher prices, and taxes on consumers may lead to lower prices received by producers
    b. subsidies for producers may lead to lower prices for consumers
    c. add back in any transfer payments that have been netted out of the CBA (i.e., costs to one group that are experienced as equal-sized benefits by another group, such as public transport fares or taxes). Payers and payees could be informed by the Financial Analysis.
4. Consider any unquantified effects and whether these are likely to impact significantly on any of the identified groups.
5. If appropriate, consider any mechanisms that could mitigate inequitable social impacts arising from the policy.

Distributional analysis provides supplementary information alongside the NPV and BCR in a CBA. **Completing a distributional analysis may require additional information beyond that required for a standard CBA**, for example:

- Demand curves for each group would be required to estimate group-specific consumer surplus.
- Forecasts of prices are needed for the long-term distribution of taxes or subsidies between producers and consumers.
- Understanding the groups that would bear the funding costs of an initiative.
- Accounting for transfer payments, mainly indirect taxes and subsidies.

This Guide does not recommend the use of distributional weights. That is, increasing or decreasing the value of costs or benefits depending on what group they accrue to. Distributional weights involve a high degree of discretion over equity judgements that are better placed in the hands of decision-makers.

A5.3 Example templates of distributional analysis

Distributional analysis disaggregates the overall impacts of each option by stakeholder groups, identifying beneficiaries and those made worse off. Consider the hypothetical CBA results in the first table below and another example of possible distributional analysis.

56 Note, this may depend on the pricing policy identified in the CBA, for example the use of road tolls.

Table A5.2: CBA distributional analysis by cost and benefit category (illustrative example)

CBA results (present value at prevailing discount rate)	Option 1	Option 2	Option 3
Incremental costs ($m)	**$6.0**	**$24.0**	**$42.0**
Cost category 1 (e.g., Capital costs)	$1.0	$7.0	$13.0
Cost category 2 (e.g., Operating costs)	$2.0	$8.0	$14.0
Cost category 3 (e.g., Maintenance costs)	$3.0	$9.0	$15.0
Incremental benefits ($m)	**$15.0**	**$33.0**	**$51.0**
Benefit category 1 (e.g., WTP to fish)	$4.0	$10.0	$16.0
Benefit category 2 (e.g., Producer surplus)	$5.0	$11.0	$17.0
Benefit category 3 (e.g., WTP to avoid water bird loss from contamination)	$6.0	$12.0	$18.0
Net Present Value ($m)	**$9.0**	**$9.0**	**$9.0**
BCR	**2.5**	**1.4**	**1.2**

Table A5.3: CBA distributional analysis by stakeholder (illustrative example)

CBA results (present value at prevailing discount rate)	Option 1	Option 2	Option 3
Incremental costs ($m)	**$6.0**	**$24.0**	**$42.0**
Government	$6.0	$24.0	$42.0
Incremental benefits ($m)	**$15.0**	**$33.0**	**$51.0**
Consumers (i.e., use of lake)	$4.0	$10.0	$16.0
Producers (i.e., businesses)	$5.0	$11.0	$17.0
Broader community (e.g., environment gain)	$6.0	$12.0	$18.0
Net Present Value ($m)	**$9.0**	**$9.0**	**$9.0**
BCR	**Not required.**		

Kaldor-Hicks Tableau (for costs and benefits)

The Kaldor-Hicks Tableau framework **is a helpful tool to consider distributional impacts** in CBA, policy evaluation, and wider policy analysis.[57,58] Analysts could consider undertaking this analysis **for short-listed options** in the CBA.

Each row presents each cost, benefit, and transfer category with its associated final net impact. Each column presents impacts by each stakeholder identified. The final net impact column presents the usual CBA results, and the overall value-for-money and efficiency can therefore be analysed in two ways, by the sum of the:

- net impacts of each cost and benefit, or
- net distributional impacts on all stakeholders.

In the example[59] below, the CBA results (cost and benefit categories and present values) are presented in the far left and right columns, respectively.

- Key sub-groups likely impacted from the initiative are listed in the top row.
- CBA results, apportioned to respective sub-groups, are located in the centre of the table.
- Transfer payments are presented transparently across sub-groups and net to zero.

First, the key groups likely impacted from the initiative are listed in the top row. Sub-groups may be identified from initiative information and intended outcomes of the policy design.

Second, the CBA results are apportioned to respective sub-groups (where applicable) in the centre of the table. This apportionment may be **informed by various exercises** including detailed bespoke modelling, outcome attribution in the Logic Map, ex-post evaluation information, or expected distributions of Government funding across sub-groups.

Third, transfer payments, with payers and payees informed by the Financial Analysis, are included. The sum of these should net to zero.

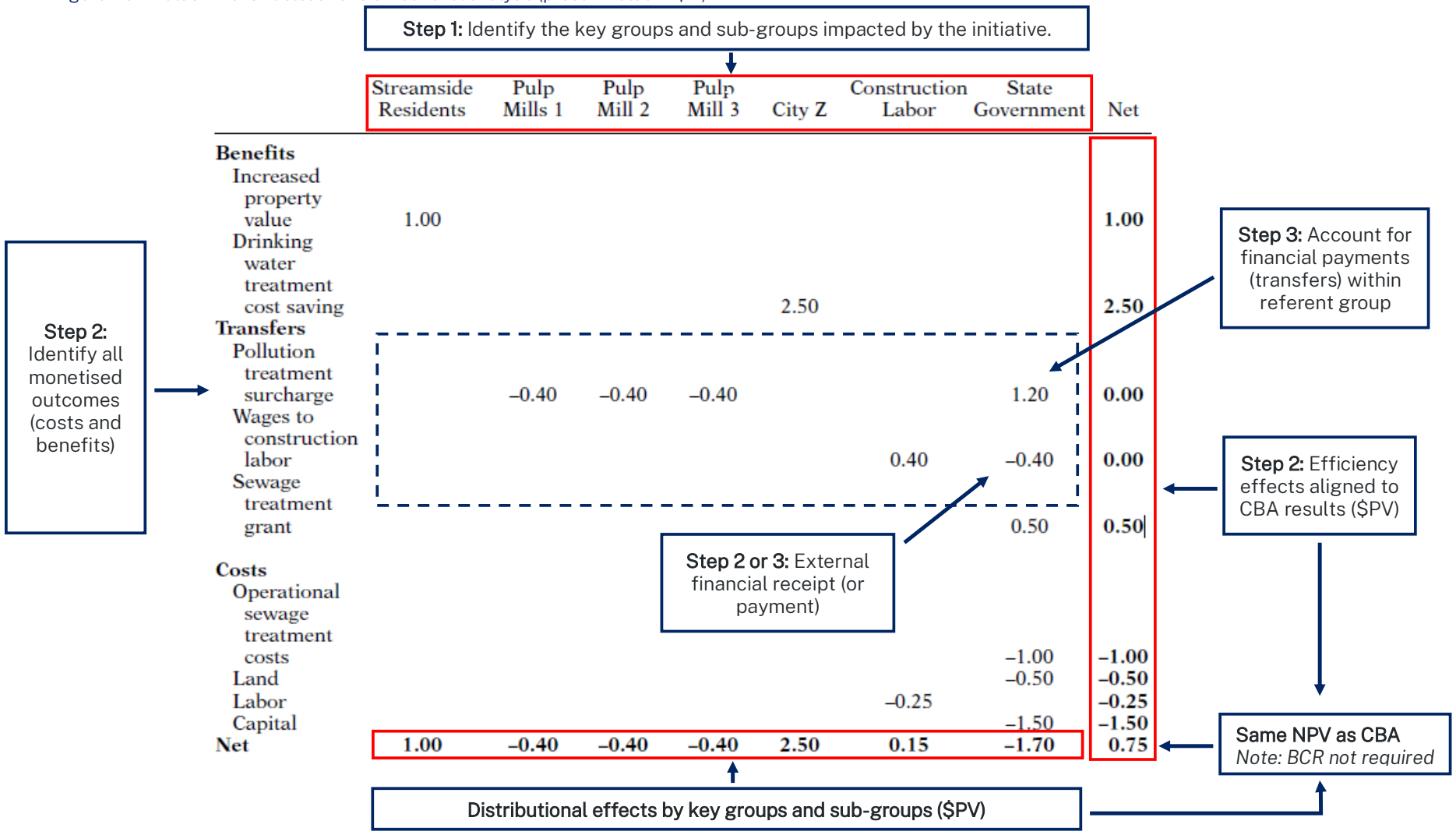
Summing each column yields the distributional effects by key sub-groups. It should be noted that the NPV in the distributional analysis will be the same as the CBA, but the BCR will differ. **Presenting the BCR in Distributional Analysis is not required.** In the example below, the city and residents are the main beneficiaries of the Government-funded initiative.

57 Krutilla K (2005) 'Using the Kaldor-Hicks tableau format for cost-benefit analysis and policy evaluation', *Journal of Policy Analysis and Management*, 24(4):864-875.

58 For a detailed example, please see the Krutilla (2005) reference above.

59 Ibid.

Figure A5.1: Kaldor-Hicks Tableau for distributional analysis (present value in $M)



Appendix 6: Discount rates in CBA

This appendix outlines the theory and practice of discounting. The mandated social discount rate is 5 per cent per annum (in real terms). Sensitivity testing should be undertaken at 3 per cent and 7 per cent per annum (in real terms).

A6.1 The concept of discounting

Costs and benefits flowing from an initiative are generally spread over time. For example, a social policy may have initial implementation costs and then benefits and operating costs extending into the future.

To compare costs and benefits occurring over different time periods, it is necessary to discount the value of future costs and benefits to determine their present value. Present value is today's value of some future stream of costs or benefits. Present values allow for decisions to be made in the present about initiatives that have costs and benefits in the future. It also allows for comparisons over time or across proposals with different analysis periods.

Discounting reflects the view that a dollar received in the future is worth less than a dollar now (for a consumer) or that a dollar invested today will not be available to invest elsewhere (for an investor). The arithmetic of discounting is represented graphically in Figure A6.1, showing the present value in Year 0 (today) of $100 received in each future year.

Figure A6.1: Stylised example of discounting under a 5 per cent per annum discount rate

Note, this form of discounting does not reflect inflation. **The social discount rate is a real rate of discount that applies to cost and benefit streams estimated in constant dollar terms** (i.e., real terms).

A6.2 Theoretical basis for the social discount rate

Social discount rates (SDR) aim to reflect the opportunity cost of resources to society in the long term. SDR are used in economic appraisal and evaluation to recognise that resources allocated to one initiative have other potential foregone uses. This is consistent with a decision-making environment of limited resources and competing uses.

The Guide uses opportunity cost of capital as the theoretical basis for determining the SDR. This approach recognises that capital is limited, and that any given public investment occurs at the expense of some alternative public, or private, investment. In this context, the 'return' on the public

investment should be compared to the hypothetical return achievable by the next-best private sector investment (the marginal opportunity cost of capital).

The most prominent alternative theoretical basis for discounting is social rate of time preference. This approach recognises that society values current consumption over future consumption. In a growing economy, society tends to value a dollar of marginal consumption today at a higher rate than a dollar of marginal consumption in the future (when incomes are assumed to be higher).

This Guide applies opportunity cost of capital approach because regardless of how public capital was originally raised, there is nearly always an investment opportunity cost. Additionally, using the opportunity cost of capital aligns closely with the efficiency criterion in CBA. Moreover, the opportunity cost of capital approach aligns New South Wales with other Australian states and territories and the Commonwealth.

The social rate of time preference approach is also theoretically sound and future iterations of the Guide will continue to consider the merits of both approaches, in consultation with other Australian treasury and finance departments.

The SDR set in the Guide applies to all initiatives

It is important to have a consistent social discount rate for all initiatives in all sectors. A different rate would imply one project or sector has a higher opportunity cost than another. If estimated stream of costs and benefits differ between initiatives, this should be reflected in the expected values of the cost and benefit flows, rather than the discount rate. Box A6.1 provides an illustrative example.

A consistent social discount rate also enables comparisons between initiatives on a 'like with like' basis. A single rate allows for consistent interpretation and comparison of CBA and evaluations across the full range of NSW Government initiatives. This helps to minimise confusion about CBA for different projects of different agencies, as initiative funding requests may be carried over to future years (where the discount rate is the same across periods).

Box A6.1: Applying a consistent discount rate

CBA does not attempt to weigh a benefit (or cost) differently once it has been estimated. To do so would be contrary to the basic valuation principles employed in CBA.

For example, take a health outcome and an environmental outcome both with benefit(s) valued at $10,000 now and approximately $6,500 in 10 years' time (assuming a 5 per cent a year discount rate). In a CBA these benefits would be treated as equivalent values, subject only to discounting.

Therefore, the same discount rate must apply to the health benefit and the environmental benefit. Moreover, the same discount rate should apply regardless of whether the health benefit or the environmental benefit is generated by a transport project, a health project or an environmental project. Once benefits have been estimated, the sector of the project does not in any way change the investment opportunity lost from public sector expenditure.

Risk adjustments and the social discount rate

It is important that the SDR reflects systematic risk. Systematic risk refers to unavoidable (non-diversifiable) market risk that affects all initiatives and cannot be reduced by further diversifying a portfolio of initiatives.

Adjusting the SDR to reflect project specific risk (also called non-systematic or diversifiable risk) could distort outcomes by altering the present value of costs and benefits as a function of time, not as a function of risk. In practice, all calculations in a CBA are subject to many sources of risk. **If one project has a higher degree of risk than another this should be reflected in the quantification of the expected values of costs and benefits,** not through adjustments to the SDR.

The social discount rate is consistent over the analysis period

For simplicity, the SDR should be stable over the analysis period.[60] The SDR in this Guide is estimated on the basis that it is a long-term opportunity cost of capital and its application over the analysis period reflects this and there is no clear way to predict future trends to the opportunity cost of capital in the long-term.

Initiatives that have very long-term impacts (e.g., hundreds of years in the future) that may involve intergenerational equity considerations tend to be the main rationale for declining discount rates.[61] This does not closely align with the efficiency criterion of CBA or the opportunity cost of capital theory where the wellbeing of future generations is best served by investing and reinvesting in the highest available return.

Further, as much of the discounting has already occurred by year 100, the impact on the results is unlikely to be meaningful to include this type of complexity. Appendix 6 outlines how to present distributional effects, which are a separate consideration. As discussed in Appendix 4.2, **sensitivity analysis is the most practical approach to test the effect of alternative discount rates.**

A6.3 Empirical benchmarks to calibrate social discount rates

There are **two main empirical benchmarks that can be used to calibrate the long-term social discount rate** based on the real pre-tax opportunity cost of capital:

1. **Forward looking benchmarks** derived from the Capital Asset Pricing Model or Weighted Average Cost of Capital.
2. **Backward looking benchmarks** derived from the Australian National Accounts.

Applying either approach there is evidence to suggest that discount rates have fallen over time.

Recent Treasury analysis indicates that the pre-tax real long-term opportunity cost of capital is approximately 5 per cent a year. This estimate is within the range of estimates found elsewhere, discussed next, but more importantly it is reflective of the longer-term decline in the opportunity cost of capital.

The Independent Pricing and Regulatory Authority (IPART) uses current market data and long-term averages to estimate the Weighted Average Cost of Capital (WACC) for a 'benchmark' regulated

60 This assumption does not apply for an ex-post CBA, should the discount rate change during the evaluation period.

61 Weitzman ML (1998) 'Why the far-distant future should be discounted at its lowest possible rate', *Journal of Environmental Economics and Management*, 36:201-208, proposed that when there is uncertainty about the discount rate, the discount rate mathematically is similar to a deterministic discount rate that declines over time. This does not mean the discount rate declines over time just that a stochastic discount rate that accounts for uncertainty requires a declining discount rate. Weisbach D, Sunstein CR (2009) 'Climate change and discounting the future: a guide for the perplexed', *27 Yale Law and Policy Review* 433, conclude that projects, including climate change, should be evaluated by discounting at the market rate of return, properly adjusted for uncertainty and the inherent value of the environment.

business. IPART publishes both a short term (40-day) and long term (10 year) measure of the WACC based on a standard gearing ratio (60 per cent) and average market volatility (equity beta of 1). The most recent pre-tax real long term WACC (August 2022) is 4.5 per cent,[62] compared to 7.2 per cent in (February) 2017, which shows considering the forward-looking approach, the social discount rate has decline over time.

More than a decade ago the Australian Productivity Commission published a paper authored by visiting researcher Harrison (2010) that reported a real pre-tax rate of return on capital in Australia of 8.9 per cent.[63] This figure is based on Dolman (2007) and is derived from Australian National Accounts data.[64] The research paper considers this estimate to be 'consistent with other national accounts based estimates of the before-tax rate of return to investment in Australia and the United States and with estimates of the cost of capital in Australia'. More recently, Fernandez (2019), applying a similar approach, reported a real pre-tax rate of return of 6.8 per cent.[65] Similar to the results of the forward-looking benchmark, these analyses show that when considering the backwards-looking approach, the social discount rate has declined over time.

Therefore, based on the two main empirical benchmarks and analyses of each over time, it is evident the long-term social discount rate has declined.

It is important to note that the nominal benchmark Government long term bond rate is not a relevant empirical benchmark for calibrating the opportunity cost of capital because the government's ability to borrow at a lower rate than private parties derive from its powers to raise compulsory taxes from the community (which impose welfare losses on the economy).

A6.4 The recommended social discount rate

Based on the considerations above, **economic appraisals and evaluations must use a 5 per cent a year real central estimate social discount rate. Sensitivity testing is to be undertaken using a lower bound of 3 per cent and an upper bound of 7 per cent per annum (real)**.

The social discount rate is a parameter and has been calibrated based on long-term empirical benchmarks of the opportunity cost of capital. It is, however, appropriate to periodically review this parameter. **Treasury will consider undertaking a review** earlier should economic circumstances change sufficiently.

While this Guide uses the opportunity cost of capital as the theoretical basis for the social discount rate, it is acknowledged that there are competing theories, and this can lead to different discount rates. For example, while dated, Harrison (2010) canvasses estimates in recent decades ranging from 1 per cent to 15 per cent depending on the approach taken – 1 per cent to 5 per cent for time preference rates, and 5 per cent to 15 per cent for opportunity cost of capital rates.[66]

62 See https://www.ipart.nsw.gov.au/Home/Industries/Special-Reviews/Regulatory-policy/WACC for further information about IPART's WACC methodology. At the time of writing, the pre-tax long term WACC estimate can be found in the spreadsheet model accompanying IPART's WACC Biannual Updates.

63 Harrison M (2010) *Valuing the future: the social discount rate in cost-benefit analysis*, Productivity Commission.

64 Dolman B (2007) 'The distribution of recent economic gains: some early observations' [presentation] *Productivity Perspectives* Conference, Canberra.

65 Fernandez R (2019) 'Review of discount rates used in economic evaluations', *Victoria's Economic Bulletin*, 24-32.

66 Harrison M (2010) *Valuing the future: the social discount rate in cost-benefit analysis, productivity commission* Chapter 3, canvasses various discount rate concepts and benchmarks, and distinguishes between descriptive and prescriptive approaches to setting the social discount rate. The prescriptive approach mixes efficiency and equity considerations and provides a wide range of suggested discount rates that reflect different value judgements which cannot be resolved objectively.

As such, sensitivity analysis is important when using a social discount rate in an economic appraisal and evaluation. The sensitivity tests of 3 per cent, and 7 per cent, represent a meaningful range and should be used to test whether the outcome of the appraisal or evaluation changes significantly with the discount rate.

Appendix 7: CBA Results and decision criteria

This section describes the key results in CBA, as well as the key decision criteria to apply when interpreting these results.

A7.1 Results and decision criteria

This section explains how the Net Present Value (NPV) and Benefit-Cost Ratio (BCR) are calculated and how each should be used to inform decision-making in different circumstances. While this section focuses on quantitative results, it is important to present these results in the context of the entire analysis. This should include an outline of:

- inputs and assumptions used in quantification
- results of sensitivity analysis
- distributional analysis
- qualitative costs and benefits (Section 2.8 provides further information on reporting results).

The key results of a CBA are the:

- **Net Present Value (NPV),** and
- **Benefit Cost Ratio (BCR)**

Note, the method for calculating BCR has been updated from the previous Guide (TPP17-03).

NPV and BCR both indicate whether an option's benefits exceed its costs in present value terms for a given discount rate (NPV above zero; BCR above one). Options where costs exceed benefits in present value terms (NPV below zero; BCR below one) indicate that overall social welfare is reduced.

Note, the NPV and BCR:

- Show results for benefits and costs that have been quantified, therefore, it may be possible that unquantified (or unquantifiable) impacts could affect the results in either direction.
- Central estimate may change with different assumptions for parameters used, usually shown through sensitivity analysis.

Net Present Value (NPV)

The NPV of an option is the sum of the present value of benefits that have been valued, less the sum of the present value of costs that have been valued (shown in Formula 7.1) **in absolute terms — i.e., in dollar amounts**.

An NPV above zero indicates that benefits outweigh costs and measures the net social benefit (or welfare gain) to society from undertaking an initiative compared to the base case. A NPV below zero represents a net social cost (or welfare loss) to society.

Formula 7.1 – Net Present Value (NPV)

$$NPV = \sum_{t=0}^{T} \frac{B_t - C_t}{(1+r)^t}$$

Where: B_t = Project benefits in year t expressed in real terms (i.e., excluding inflation)

C_t = Project costs in year t expressed in real terms (i.e., excluding inflation)

r = Real social discount rate

T = Number of years in the analysis period

Benefit Cost Ratio (BCR)

The BCR of an option is the ratio of the sum of the present value of benefits to the sum of the present value of costs (shown in Formula 7.2). A BCR greater than one indicates that benefits outweigh costs.

Formula 7.2 – Benefit Cost Ratio

$$BCR = \sum_{t=0}^{T} \frac{B_t}{(1+r)^t} \Big/ \sum_{t=0}^{T} \frac{C_t}{(1+r)^t}$$

Where: B_t = Project benefits less disbenefits (if any) in year t expressed in real terms (i.e., excluding inflation)

C_t = Project costs in year t expressed in real terms (i.e., excluding inflation)

r = Real social discount rate

T = Number of years in the analysis period

In Formula 7.2:

- Project (resource) costs incurred by NSW entities (primarily, but not exclusively, NSW Government) to deliver the initiative (i.e., capital **and** operating costs) **should be included in C_t, that is, in the denominator**.
- **Negative externalities (sometimes referred to as disbenefits) should be included in B_t that is, the numerator**. Negative externalities are indirect costs resulting from the initiative that are borne by third parties. They are not in C_t because they are not drawn from a constrained pool of funds.
- **Cost savings** are identified as a benefit in this Guide and should be included in B_t, that is in the numerator. For example, recurrent cost savings may occur where operating and maintenance costs are lower under the initiative than in the base case. It may also be necessary to offset the avoided benefits associated with avoided costs, where applicable.

Box A7.1 expands on Formula 7.2 to show where benefit and cost categories should be placed to ensure consistent reporting of the BCR.

Initiatives with no project resource costs

Some initiatives, such as regulatory proposals, may have zero (or very close to zero) project resource costs. In these cases, a BCR is not calculable under Formula 7.2. Because initiatives with no project resource costs do not draw funding from a constrained pool of funds, this Guide suggests that calculating a BCR for such initiatives is usually not essential.

If a BCR needs to be calculated for an initiative with zero project resource costs, for presentational or policy reasons, then agencies should calculate an alternate BCR referred to here as a '**welfare ratio**'. The welfare ratio is calculated using the same method as the BCR (Formula 7.2) **except** disbenefits are included in the denominator (C_t in Formula 7.2) instead of in the numerator (B_t in Formula 7.2).

Initiatives with a negative BCR

In rare cases, it will be possible for CBA of an initiative to return a negative BCR (BCR < 0) using Formula 7.2. This is not possible under alternate BCR formulas where only positive terms can be included in the numerator. A negative BCR:

- can occur if, and only if, disbenefits (i.e., negative externalities) are larger in absolute value than benefits for an initiative
- indicates the initiative will do 'more harm than good' in terms of its outcomes, meaning it will reduce social welfare regardless of its project resource costs.

Negative BCRs should not be used to rank initiatives by BCR. Generally, an initiative with a negative BCR can immediately be ranked below any initiative with a positive BCR and should not be pursued. If it is absolutely necessary to rank initiatives with negative BCR against each other, they should be ranked by NPV (indicating which initiative does the least amount of harm).

Box A7.1: Benefit-Cost Ration (BCR) Formula

To promote consistency in presentation of the BCR, this Box links the Benefit and Cost categories identified in Chapter 2 (Tables 2.4 and 2.5) to Formula 7.2. It identifies which categories go into the numerator and the denominator.

$$\frac{\boldsymbol{B_t = B_1 + B_2 + B_3 + B_4 + B_5 + (B_6 - C_5) + B_7}}{\boldsymbol{C_t = C_1 + C_2 + C_4}}$$

Where:

$\boldsymbol{B_1}$ = Savings or avoided costs

$\boldsymbol{B_2}$ = Government revenue

$\boldsymbol{B_3}$ = Consumer surplus

$\boldsymbol{B_4}$ = Producer surplus

$\boldsymbol{B_5}$ = Labour surplus

$\boldsymbol{B_6}$ = Benefits to the broader community (i.e., positive externalities)

$\boldsymbol{C_5}$ = Costs to the broader community (i.e., negative externalities)

$\boldsymbol{B_7}$ = Residual value

$\boldsymbol{C_1}$ = Capital costs

$\boldsymbol{C_2}$ = Recurrent costs

$\boldsymbol{C_4}$ = Ancillary costs (e.g., transaction costs)

Note:

$\boldsymbol{C_3}$, regulatory costs, are mostly relevant for Regulatory Impact Statements. In this instance, these costs would go into the denominator ($\boldsymbol{C_t}$).

How to use each result to inform various decisions

If NPV and BCR produce the same ranking of options within a CBA, then either can be used to rank those options, and both should be reported.

Table A7.1 provides context on how to use NPV and BCR.

Table A7.1: How to use the NPV and BCR

Criteria	Context
NPV	NPV can be used: • to make an 'accept or reject' decision for an individual initiative • to compare mutually exclusive options (i.e., a set of options of which only one can be implemented) — Mutually exclusive options can include alternative implementation timing(s) or alternative project design for the same initiative. • to compare alternative combinations of related initiatives where implementation of one initiative affects the benefits and/or costs of another (i.e., where the initiatives are not independent).
BCR	BCR can be used: • to rank initiatives to maximise net benefits to society from a portfolio of independent initiatives when there is a budget constraint.[67] — The budget constraint refers to decision makers' funding constraint. • to make an 'accept or reject' decision for an individual initiative.
Note: • Classification of costs and benefits does not affect NPV results but can impact BCR results. • BCR results calculated according to Formula 7.2 cannot be compared with other specifications of the BCR to rank options. • BCR should not be used to rank mutually exclusive projects. • In certain niche cases, such as ranking a mix of independent and mutually exclusive initiatives, linear programming techniques may be required to rank proposals, but this is uncommon and not discussed in this Guide.	

Note, if decision makers are seeking to rank projects strictly within a fixed pool of NSW Government funds, another metric known as 'NPV/I' can be useful. NPV/I is the ratio of NPV of an initiative (NPV as defined in Formula 7.1) to the amount of Government investment required to implement the initiative (i.e., capital, operating and ancillary costs incurred by the NSW Government only).

67 A budget constraint can be defined in reference to an individual agency, a cluster, the whole of government, or NSW community depending on the pool of proposals that are being selected or ranked. In this Guide it mainly, but not always, refers to whole of government.

Appendix 8: Other analytical and modelling approaches

This appendix discusses other techniques for assessing or informing projects and programs seeking government funding:

- Preliminary Cost-Benefit Analysis
- Cost-Effectiveness Analysis (CEA) or Cost-Utility Analysis (CUA)
- Multi-Criteria Analysis
- Economic impact assessment (input-output analysis, and computable general equilibrium (CGE) modelling).

The advantages and limitations of these techniques should be considered in deciding whether they provide helpful information for decision makers. These techniques, by themselves, do not assess net social benefit of proposals, but they may be useful complements or supplements for CBA. They do not, however, substitute for a CBA, except in certain cases where CEA (or CUA) may substitute for CBA (these need to be determined with Treasury on a case-by-case basis).

A8.1 Preliminary Cost-Benefit Analysis

CBA may suffer from limitations in data or analytical resources that could make it difficult to undertake a fully developed analysis. However, the process of undertaking some form of CBA still provides a transparent and logical process to set out the potential impacts of an initiative. A preliminary CBA, a less detailed form of CBA with principles still based on welfare economics, can be a useful tool to apply in certain circumstances. Various jurisdictional and other guidance discuss such analysis under different titles (e.g., rapid CBA) with some variations on necessary requirements, but effectively cover the same process. See Table A8.1 for a summary of other guidance commenting on short-form CBAs.

Table A8.1: Example of short-form CBAs in guidance and literature

Source	Examples
Infrastructure Australia (IA), *Guide to economic appraisal*, Rapid CBA	Applies standard CBA principles and techniques but focuses on quantifying the most material economic costs and benefits. It is less intensive and most suitable as an early indicator of a proposal's impact. IA's approach more closely aligns with their Strategic Business Case process and is 'rapid' compared to a fully detailed CBA required to select the 'preferred' option.
New Zealand Treasury, *Guide to Social Cost Benefit Analysis*	Rough CBA – The roughest CBA – Qualitative CBA (*not recommended*) Rough CBA – The next level up – CBA with rough quantification (*recommended*)
Boardman et al, *Cost-Benefit Analysis: Concepts*	Qualitative CBA – this approach requires analysts to quantify as many of the impacts as possible, and include qualitative estimates for the rest, making use of estimates from other CBA analyses or research.

Source	Examples
and Practice, 5th edition	

The **New Zealand Treasury 'the next level up'** and **IA's rapid CBA** approach are consistent with our view of what a preliminary CBA should cover.

Examples for where a preliminary CBA might be useful include:

- Initiatives that are below the threshold requirements for a Business Case (i.e., below $10M), but some analysis would be useful to understand the potential for a net benefit to exist.
- General (small-scale) grant programs (applying standardised valuations). This analysis could be assisted through the development of a spreadsheet model that automates a CBA-type process, with standard parameters, following the inclusion of relevant data from proponents.
- Proposals for program funding envelopes without clear projects yet available for assessment (conditional on the scale of funding being considered).

Agencies should discuss with Treasury before proceeding to agree on its suitability for use.

A8.2 Cost-Effectiveness Analysis

Cost effectiveness analysis (CEA) shows the costs of achieving a given outcome. The aim is to achieve the outcome(s) at the lowest cost. **CEA is used to compare the costs of different options where outcomes are taken as given or considered equivalent among options**.

CEA was previously applied in cases where CBA was not possible, mainly due to difficulties in valuing the major benefits in dollar terms. In recent decades, however, methods have been developed to value benefits which could not previously be quantified, usually in the human services sectors, e.g., health, education, and disability services. Although, where benefit streams for one benefit category differs between two options, then we consider there may be sufficient grounds to proceed with a CBA. **Therefore, CBA is the preferred appraisal approach**.

CEA may be considered if some of the following factors are observed:

- it is not possible to value the major benefits in monetary terms
- benefit valuation and data collection are likely to be expensive relative to the cost of the initiative
- it is early in the options development process and differences between option benefits cannot yet be discerned.

CEA is most applicable when all the options have the same or similar degree of effectiveness, **but target the same outcomes**, because the aim simplifies to minimising cost for the given outcome. In many cases, however, carrying out a CEA is not that simple because:

- different options have different degrees of effectiveness, or
- the 'business as usual' option represents a lower level of services.

The steps in conducting a CEA are similar to those for a CBA, except benefits are typically not quantified in a CEA. CEA requires similar evidence as CBA, but CEA only shows the least cost option.

In some cases, it may be possible to assume a linear relationship between effort (expenditure) and effectiveness (outcomes). For example, if it can be established that one option is twice as effective as another, it may be possible to compare the costs of the options more easily.

In other cases, the equivalent effectiveness could be inferred – for example, through the application of a uniform set of physical standards. This approach should be taken with great care because uniform standards can potentially impose inefficient costs (e.g., some buildings may not all require identical physical attributes or features to deliver similar performance outcomes).

In instances where the above alternatives are not feasible, the appraisal should describe the effectiveness of each option as fully as possible. Where assumptions are made about the degree of effectiveness versus cost, the agency should document assumptions made and supporting evidence. These assumptions could be based on post-implementation reviews of past programs, or precedents in other Australian jurisdictions or elsewhere, and may be subject to appropriate qualifications (e.g., differences in statutory or regulatory regimes among jurisdictions).

The major disadvantages of CEA are:

- it cannot be used to compare initiatives with different outcomes or objectives that are not directly comparable
- unlike CBA, CEA cannot indicate whether the preferred option provides a net benefit to society
- it is possible that the **preferred option in a CEA could result in a net cost rather than a net benefit to society**.

For these reasons, **where CEA is used initially, agencies should aim to collect better information from post evaluations over time to enable a transition to CBA** when changes in policy, analytical techniques or data availability make CBA feasible.

A variation of CEA, referred to as **cost-utility analysis** (CUA), estimates costs in monetary terms and benefits expressed as either Quality-Adjusted Life Years (QALY) or Disability-Adjusted Life Years (DALY). QALYs are changes in welfare (utility) associated with an improvement in the length of life or quality of life. CUA is often used in health-related initiatives.[68,69]

A8.3 Multi-Criteria Analysis (MCA)

Multi-criteria analysis (MCA) entails identifying criteria, assigning weights to them, and then scoring options on how well they perform against each weighted criterion. The sum of the weighted scores is used to rank each option against others. A simpler variant could entail listing the performance criteria to be considered and assessing each option, program, or project on whether or not it meets those criteria.[70]

A **CBA with valuations is preferred over MCA**. At an early stage some understanding of cost and the primary outcome should be known, hence CEA may also be preferred to MCA or at least complementary. **MCA may be useful** where it is not possible or practical to value all costs or

68 CUA estimates the ratio between the cost of an intervention and the benefit that the intervention generates, where the latter is measured by QALYs – a QALY value of 1.0 applies to each year lived in perfect health, or 0.0 if dead. If not lived in full health, a QALY would be valued between 0 and 1. One DALY represents the loss of the equivalent of one year of full health. DALYs for a disease or health condition are the sum of the years of life lost (YLLs) to due to premature mortality and the years lived with a disability (YLDs) due to prevalent cases of the disease or health condition in a population.

69 Another approach typically applied for health interventions includes Cost-Consequence Analysis (CCA), which is a systematic description and measurement of a set of intervention attributes that should be considered when making a decision. CCA does not prescribe a decision rule and provides the building blocks for more detailed analytical methods such as CUA and CBA.

70 UK Treasury (2011) *Green Book: Appraisal and Evaluation in Central Government*, p 35.

benefits in monetary terms in an efficient and timely manner before undertaking a CBA or CEA to assess the long-listed options.[71]

MCA has some advantages relative to informal and undocumented judgment but does not substitute for CBA or CEA.[72] MCA can provide a degree of structure to the early-stage assessment process. It can be open, explicit, relatively simple, require less detailed information than CBA or CEA and permit the assessment process to be documented for future reference.[73]

The main limitations of MCA compared to CBA are:

- Preconceptions or biases within decision makers, analysts, or stakeholders consulted, may not be readily detected or amenable to review or replication and they may apply their own personal objectives, criteria, and weights, which may not accord with the preferences of society as a whole.
- Putting numbers on what are essentially qualitative assessments can give a false impression of scientific certainty, since the number produced by one MCA cannot be replicated or compared with the number produced by another and is not objectively testable.
- MCA is not founded on any principles of welfare measurement and therefore cannot show whether a program or option adds to, or subtracts from, social welfare. Unlike CBA, MCA does not require that benefits exceed costs nor identify when the base case might be preferable.
- MCA is not denominated in monetary terms and cannot compare projects and options from a net social welfare perspective.
- In practice MCA can inadvertently include contradictory criteria, or double count complementary criteria making it difficult to interpret the results of the analysis for fiscal decision-making purposes.

Use of CBA instead of MCA in areas such as environmental and social policy does not mean the criteria considered are only those that can be valued in dollars. The quantified CBA result is one input into the decision-making process, and it is considered alongside qualitative benefits and other factors (see the 'Five Cases' in the NSW Government Business Case Guidelines).

The Guide suggests that at the '**very long list'** stage of assessing potential options, MCA may be a cost-efficient method to inform analysis. If undertaken, the criteria and weightings in the MCA should be aligned to a future CBA.

A8.4 Economic Impact Analysis

Economic impact analysis is not an alternative analytical approach, it mainly shows how economic activity (e.g., GDP, private consumption, investment, exports, employment and industry outputs) changes due to a specific initiative, such as a project or policy change, typically called 'shocks'. Estimates of GDP changes from economic impact models and net benefits from a CBA **are not interchangeable, nor additive**. Economic impact analysis, however, **can provide complementary information** to decision makers or, depending on the methodology, inputs into a CBA.

71 Note; the long-list of options in this CBA Guide appears analogous to the 'filtered list' described in Infrastructure Australia's Guide to multi-criteria analysis.

72 UK Department for Communities and Local Government (2009) *Multi-Criteria Analysis: A Manual*, London, 19-21. See also Dobes L and Bennett J (2009) 'Multi-criteria analysis: "Good Enough" for government work?', *Agenda: A Journal of Policy Analysis and Reform*, Accessed at https://openresearch-repository.anu.edu.au/handle/10440/1065.

73 For guidance on how to undertake MCA well, see: https://www.infrastructureaustralia.gov.au/guide-multi-criteria-analysis.

Input-Output (Multiplier) Analysis

Input-Output (I-O) Multiplier Analysis is commonly used to assess the impacts of a given initiative, often in reference to States or specific regions. Simply put, multipliers are applied to measures of direct expenditure to give estimates of direct and indirect flow-on impacts. Commonly assessed impacts include output, employment, and income. I-O analysis and multipliers are related but not equivalent concepts. Multiplier analysis is subject to significant limitations,[74] and **should not be used to measure social welfare in appraisal of initiatives**.

Input-Output Analysis, however, may be useful to analysts or consultants *to identify* first-round direct and indirect producers and suppliers when considering changes to producer surplus and related market impacts, as discussed in Section 2.3.

Computable General Equilibrium (CGE) Modelling

A general equilibrium approach to assessing economic impacts applies a whole-of-economy lens to modelling the economy. CGE models (also called multimarket models) are an example of this approach, with analytical capabilities ranging from a regional, national, to an international level. A typical model comprises many equations, representing the behaviours and relationships between industries and institutional sectors of the economy.

This modelling approach aims to estimate the effect, and new equilibrium, of a change in one variable on all other related variables. **CGE models focus on the effects of exogenous demand and supply changes ('shocks') on economic activity, income, or employment**. These models address the main limitations of I-O analysis by allowing for input supply constraints and variable prices.[75] They indicate how an economy may react to changes in policy, technology, or other exogenous factors instead of expenditure alone.

CGE modelling is best used for assessing the macroeconomic impacts of a portfolio of initiatives of significant size, a large body of reforms, tax and trade policy, climate change, and price changes. **CGE models are of limited use for microeconomic initiative appraisal, selection and ranking based on social welfare**. Macroeconomic parameters in CGE models may not always be directly applicable to initiatives that do not have economy-wide effects on prices. CGE modelling might be considered for very large initiatives with significant geographical and distributional impacts.

CGE complements and may inform but does not substitute for a good quality CBA. It may, however, be used to model inputs that can be used in CBA, some considerations include:[76]

- **Scope** – A CBA generally includes social, environmental and any other non-monetary impacts, which generally need to be considered outside of the CGE model.
- **Treatment of costs** – CGE modelling should treat costs consistently with CBA by classifying construction expenditure as a cost, reflecting opportunity cost.
- **Welfare indicators** – CGE models typically present key economic indicators including GDP, consumption, and income which differ from welfare. Demand and production functions in the model equations may need to be used to estimate economic surplus and social welfare akin to CBA. Where CGE results present **measures of social welfare consistent with CBA they should be fully documented, and heuristics developed to allow for results to be checked**.
- **Model closure** – a CGE model has many equations, each explaining a model determined variable. As there are more variables than equations, some variables need to be treated as exogenous

74 5209.0.55.001 - Australian National Accounts: Input-Output Tables - Electronic Publication, Final release 2006-07 tables: https://www.abs.gov.au/ausstats/abs@.nsf/Previousproducts/5209.0.55.001Main%20Features4Final%20release%202006-07%20tables.

75 ibid.

76 Queensland Productivity Commission (2018) 'Whole-of-economy modelling: beyond the black box', Staff Research Paper, 11-12.

(modeller determined). A 'closure' specifies which variables are determined exogenously and endogenously and **should be fully documented**.

CGE models can also be used to evaluate distributional effects of an initiative or reform on the economy and at different levels of disaggregation – e.g., impacts on consumers and businesses at the state or national level. Care should be taken when modelling highly disaggregated groups (e.g., regional level) due to the limited quality data.

CGE models provide a more complete picture of the impact on the economy than I-O analysis, but analysts' procuring this type of modelling or decision makers' considering results should be aware of the following considerations:[77]

- CGE modelling relies on the skill and decision of the modeller (e.g., input assumptions to various sectors of the economy) and may not provide an objective lens to evaluate and compare competing proposals on a 'like-with-like' basis.
- All government initiatives have some economic impact on the economy, this does not mean that social welfare has improved. For example, although increased employment and income are important factors, they are unlikely the main objective of a hospital, rail line or national park. A CBA is better to measure the change in social welfare directly from users benefitting from these services.
- Depending on the model's structure, CGE modelling may not necessarily account for the opportunity cost associated with investment in particular initiatives.

As CGE models typically rely on historical aggregated data and are based on relatively inflexible conditions, they may not always provide a realistic projection of the future for *individual* initiatives.

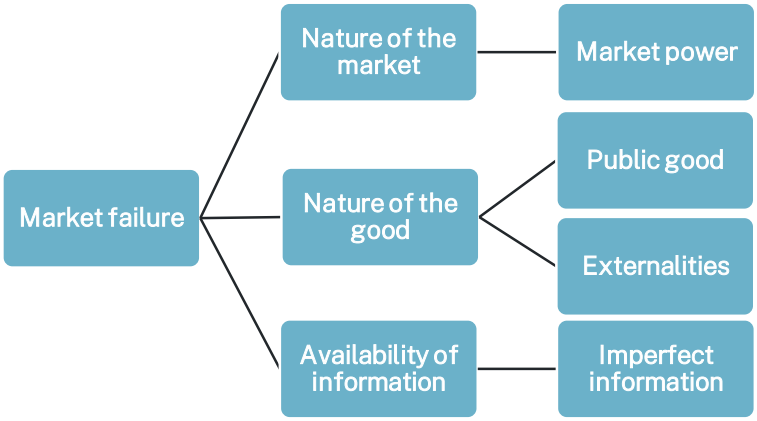
77 For common examples of CGE modelling issues, see Ibid, p 14.

Appendix 9: Types of market failure

Market failure refers to a situation where the private market fails to supply a socially optimal level of a good or service. Considering the role of market failures is a valuable step in establishing an initiative's problem definition and rationale for government action.

There are four main types of market failure, depicted in Figure A9.1. Refer to the NSW Department of Industry (PUB17/509) Market failure guide — A guide to categorising market failures for government policy development and evaluation for detailed guidance on market failure.

Figure A9.1: Market failure categories



Unintended consequences

In some cases, government interventions that aim to correct market failures can fall short of achieving a socially efficient allocation of resources. Previous government interventions may have produced ineffective, inefficient, or inequitable outcomes due to unintended consequences.

Similar to market failure, where failures of government interventions exist, there is a potential role for government to intervene to improve outcomes. These circumstances should be considered as a case for change and rationale for government action

Appendix 10: Supplementary Guidance

This appendix references supplementary resources which may be useful when undertaking CBA. These are not alternatives to The Guide. **Where applicable, these frameworks should be used in conjunction with The Guide.** Analysts are encouraged to engage with the owners of these documents when they are used to inform CBA.

Supplementary guidance may be useful when assessing initiatives that:

- are too small to justify the cost of bespoke research such as WTP surveys
- relate to a sector with a defined assessment framework (e.g., education infrastructure)
- involve common cost/benefit streams (e.g., travel time savings).

Guidance targeted at a specific sector can still be used to inform CBAs in different sectors. For example, congestion cost parameters from a transport framework may be useful when assessing infrastructure projects which generate more congestion.

A10.1 Sector-specific frameworks

Specialised frameworks have been designed to assist analysts assessing proposals in certain sectors. Specific guidance which can inform CBA includes:

- Infrastructure Australia (July 2021), Guide to economic appraisal
- NSW Department of Customer Service (Draft 2023), **Addendum: Cost-Benefit Analysis – ICT and Digital** (*please contact for guidelines*)
- NSW Department of Communities & Justice (June 2020), **A guide to Cost-Benefit Analysis for new policy proposals – Best practice cost-benefit analysis** (*please contact for guidelines*)
- NSW Department of Communities & Justice (January 2023), **A guide to measuring economic and social benefits for justice systems proposals** (*please contact for guidelines*)
- NSW Department of Planning & Environment (September 2020), Guidelines for using cost-benefit analysis to assess coastal management options
- NSW Department of Planning & Environment (December 2015), Guidelines for the economic assessment of mining and coal seam gas proposals
- NSW Department of Planning & Environment (March 2022), Interim framework for valuing green infrastructure and public spaces (https://www.dpie.nsw.gov.au/__data/assets/pdf_file/0005/502772/interim-framework-for-valuing-green-infrastructure-and-public-spaces-2022-03.pdf)
- NSW Department of Planning & Environment (April 2022), Options assessment process
- NSW Department of Industry (March 2018), Safe and secure water program – cost benefit analysis guiding principles
- NSW Health (October 2018), Guide to cost-benefit analysis of health capital projects (https://www1.health.nsw.gov.au/pds/ActivePDSDocuments/GL2018_021.pdf)
- NSW Treasury (March 2017), Cost-benefit analysis framework for government advertising and information campaigns
- Transport for NSW (2019 version 2.0), Cost-Benefit Analysis Guide.

A10.2 Parameter resources

Treasury's outcome values database (OVD) is a repository of quality assured parameters suitable for use in CBA.

In addition to this, parameter sources available to analysts include INFFEWS (September 2020), INFFEWS Value Tool.

A10.3 Modelling tools

Generic modelling tools provide a framework for calculating a BCR given forecast cost and benefit streams. These are generally simple to use but offer less flexibility than a made-to-measure model.

INFFEWS (March 2019), INFFEWS Benefit Cost Analysis Tool.

Glossary

Term	Definition
Additionality	A concept used to account for net increases in benefits, that is, an increase in benefits to the referent group with the initiative relative to the base case. Consideration of the base case is essential to determine true additionality.
Altruistic values	The value individuals place on someone else's use of a good or service, including use by future generations.
Analysis period	The period that defines the start and end date of a CBA.
Attribution	The extent to which a change is caused by, or attributable to, an initiative (relative to other external factors/causes).
Base case	In CBA, the base case is the projection of costs and benefits if none of the options proceed. It is a 'business as usual' situation, sometimes referred to as the 'counterfactual'.
Base year	The year to which all values are discounted when determining a present value.
Benefit	An increase in welfare associated with an initiative's outcomes (including economic, social, environmental or cultural outcomes). Benefits need to be first be understood as changes in condition, i.e., outcomes. In CBA, benefits are a measure of the value of the outcomes of an initiative to the NSW community – they may be monetary or non-monetary (methods exist to monetise non-market benefits).
Benefit Realisation Management (BRM)	A process of identifying, organising, managing and measuring benefits so that intended benefits are achieved. It is a continuous process running through the whole life of the initiative.
Benefit-Cost Ratio (BCR)	The ratio of the present value of net benefits to the present value of resource costs.
Benefit transfer	A valuation method that draws valuations from existing studies to use as proxy values for benefits or costs of the current initiative.
Cost Benefit Analysis (CBA)	A holistic appraisal method that estimates the economic, social, environmental and cultural costs and benefits of an initiative and expresses them in monetary terms.
CBA *Ex ante*	CBA undertaken prior to the implementation of an initiative.
CBA *Ex post*	CBA evaluation undertaken when an initiative is either underway (referred to as interim or 'in media res' *ex post* CBA) or completed (final *ex post* CBA).

Term	Definition
Computable general equilibrium (CGE) models	Economic models that show how an economy as a whole may respond to changes in policy, technology or other exogenous factors.
Consumer surplus	The situation where a consumer receives a good or service at a lower price than the maximum they are willing to pay.
Cost Effectiveness Analysis (CEA)	A form of economic evaluation that compares the costs of different options to achieve a given outcome.
Costs	Costs include the direct and indirect costs (monetary and non-monetary) of implementing an initiative.
Cost-utility analysis	A form of economic evaluation that estimates costs in monetary terms and benefits in either Quality-Adjusted Life Years or Disability-Adjusted Life Years.
Defensive and corrective expenditure	Expenditure that mitigates the negative impact of an event before it occurs or reduces damages after it occurs.
Direct impacts	Impacts on producers and consumers of goods or services associated with an initiative.
Displacement	Displacement occurs when another activity is 'crowded out', relocated or partially reduced somewhere else in New South Wales, e.g., where a supported NSW business takes market share away from an unsupported NSW business.
Distributional analysis	Distributional analysis disaggregates the overall impacts of each option in a CBA to indicate which groups bear costs or receive benefits.
Equity goals	Goal(s) to reduce identified disparities between sub-groups within a population.
Evaluation	A systematic and transparent process that can be used to assess the appropriateness, efficiency, effectiveness or net social benefits of an initiative.
Evidence	Information or a body of facts, quantitative or qualitative, that can be used to assess the validity of a proposition or inform a decision. To be considered robust, evidence should be relevant to the context, credible, accurate and complete.
Expected values	Probability-weighted average of all possible outcomes associated with an initiative.
Externalities	Impacts on third parties because of production or consumption.

Term	Definition
Forecasting	Forecasting is the standard term used to describe projecting the future in CBA, making using of the best available data, evidence, techniques and assumptions. Note, however, that CBAs often use projections based on technical assumptions as opposed to producing forecasts incorporating rational expectations.
Hedonic analysis	A revealed preference valuation method. Hedonic analysis conceptualises goods as 'bundles' of attributes and assumes that the price of the good is the sum of the value of these attributes. Regression analysis can then be used to determine the values of the attributes.
Higher value land use (HVLU)	The situation where an initiative changes the amount or type of floor space that can be delivered on a piece of land.
Indirect impacts	Impacts on third parties not directly involved in the consumption or production of the primary good or service.
Initiative	Any individual project, program, policy or regulation.
Inputs	The financial, human, material, technological and information resources used to implement and deliver the initiative.
Kaldor-Hicks Tableau	The Kaldor-Hicks Tableau framework is a tool to consider distributional impacts in CBA, policy evaluation, and wider policy analysis. Each row presents each cost, benefit, and transfer category with its associated final net impact. Each column presents impacts by each stakeholder identified.
Labour surplus	The situation where a worker's actual wages are greater than the minimum they are willing to accept to do the job (i.e., their reservation wage).
Land value uplift	The situation where land value is influenced by an initiative because it makes an area more accessible or attractive to live or work in.
Leakages	Leakage is the extent to which benefits generated in New South Wales 'leak out' of New South Wales. For example, consider a business operating in New South Wales but owned predominately by overseas shareholders.
Logic Model	A diagram that illustrates how an initiative is intended to work, by systematically setting out inputs, activities and outputs, and linking these with impacts (including outcomes and benefits). May also be described as a program logic.
Market failure	A situation where the private market fails to supply a socially optimal level of a good or service.
Marginal abatement cost	Marginal abatement cost modelling (i.e., a target consistent approach) is an approach to value carbon emissions. It estimates the marginal cost of reducing emissions along a trajectory necessary to reach a defined emissions reduction target in future.

Term	Definition
Meta-analysis	Meta-analysis draws on a pool of published studies to obtain estimates on mean impacts and variations.
Monte Carlo Analysis	Monte Carlo analysis is a computerised simulation based on repeated random sampling from relevant probability distributions (assigned either based on historical data or judgement) to produce multiple simulations. These simulations are used to derive a combined frequency distribution of certain outcomes occurring.
Multi-criteria analysis (MCA)	An option assessment technique. Multi-criteria analysis entails identifying criteria, assigning weights to them, and then scoring options on how well they perform against each weighted criterion. The sum of the weighted scores is used to rank each option against others.
Multiplier impact	The flow-on impacts from increases or decreases in income as they circulate through the economy. Sometimes referred to as second-round impacts. These are generally excluded from CBA.
Net Present Value (NPV)	The difference between the present value of benefits and present value of costs.
Net social benefit	The change in welfare that is derived from an initiative. This can be measured as the difference between total benefits and total costs attributable to the initiative (includes social, economic, environmental and cultural impacts).
Non-use values	The value individuals place on a good simply for its existence, independently of any use value.
Optimism bias	A cognitive bias that results in people systematically underestimating the likelihood of negative events occurring.
Opportunity cost	The value of alternative uses foregone by using a resource or taking an action in one way.
Option values	The value individuals place on the possible use of goods.
Outcome	Changes that are attributable to the initiative outputs. Changes may be in social, economic, environmental or cultural conditions and occur in the short, medium or long term. They may include changes in lives, status, health, surroundings, knowledge, attitudes, values, behaviours or satisfaction levels.
Output	The products, services and infrastructure that result from the initiative activities.
Peer review	A process where the quality of the work is evaluated by a reviewer, external to the business area and delivery team, with subject matter expertise.

Term	Definition
Preliminary CBA	A less detailed form of CBA with principles still based on welfare economics. Can be a useful tool to apply in certain circumstances.
Present value	Value today of some future cost or benefit.
Private use value	The value that individuals, households, communities or businesses gain from using something.
Producer surplus	A situation where the price that a producer receives for a good or service is greater than the cost of production.
Real options	Provide flexibility, but not the obligation, to undertake certain actions in the future, or to alter a project pathway when risks and uncertainty become clearer.
Reference class forecasting (RCF)	RCF uses actual data on outcomes from a group of past, similar initiatives (the reference class) to inform forecasting of the current initiative's outcomes.
Referent group	Households, businesses, governments, non-government organisations and natural assets in a specified community for which the impact of government decisions or actions are measured. In this Guide, the referent group is New South Wales.
Relevance	Concept to inform the assessment of evidence. Relevance is how closely connected or related the evidence is to the policy initiative.
Reservation wage	The lowest wage rate that a worker would be willing to accept for doing a particular job in a particular location.
Revealed preference	A non-market valuation method. Revealed preference (RP) methods estimate consumers' willingness to pay (WTP) by examining their actual behaviour.
Scenario Planning	A method for accounting for risk and uncertainty in CBA. Scenario planning sets up a few plausible scenarios to test key technical, economic, political, or other uncertainties that could affect the success of an initiative.
Shadow price	Values generated from non-market valuations.
Simple parameter testing	A method for accounting for risk and uncertainty in CBA. Involves varying parameters to show how CBA results vary with changes in assumptions.
Simulation models	A source of evidence for forecasting. Simulation models provide projections based on evidence collected and analysed over many years.
Social cost of carbon	Social cost of carbon (or damage costs) modelling is an approach to value carbon emissions. It quantifies the amount of damage caused by marginal additional emissions. The cost reflects the value of damage caused by

Term	Definition
	allowing an extra unit of emission. This cost can be calculated to estimate the damage caused globally, or the damage to a particular jurisdiction.
State Outcome	The primary purpose for which public resources are invested. NSW State Outcomes are declared in Budget papers.
Stated preference	A non-market valuation method. Stated preference (SP) methods ask individuals to self-report their preferences or valuations.
Strategic merit tests	An option assessment technique. Strategic merit tests check how well the identified options align with the economic, environmental and social goals of the initiative.
Sensitivity analysis	Shows how CBA results vary with changes in assumptions.
Social discount rate (SDR)	SDR are used in economic appraisal and evaluation to recognise that resources allocated to one initiative have other potential uses which are forgone. This reflects the fact that resources are scarce and there are many competing uses of resources.
Time series data	Time series data typically draws on aggregate or average data over time for a single variable.
Transfer payments	Financial transfers between groups within New South Wales that do not involve the use of economic resources.
Triangulation	Triangulation is a way of combining data or findings from multiple sources, that investigate the same subject, to build and check the accuracy of evidence.
Travel cost studies	A revealed preference non-market valuation method. Data collected on time, travel and accommodation costs is used to estimate the demand curve and consumer surplus for community facilities.
Validity	Concept to inform the assessment of evidence. Validity relates to causality, i.e., the appropriateness of the method used to assess the attribution of outcomes to the initiative.
Value for money	Value for money is achieved when the maximum benefit is obtained from the available resources.
Welfare	Welfare is synonymous with wellbeing of an individual, group, community or the entire society (in this case, the community of New South Wales). Changes in welfare may be related to social, economic, environmental and cultural outcomes. In a CBA, social welfare refers to the aggregate change in benefits and costs across all NSW residents.
Wellbeing Valuation	Wellbeing valuation starts with an analysis of people's overall life satisfaction and then applies econometric methods to estimate the life satisfaction provided by specific non-market goods. It then converts these

Term	Definition
	into a monetary value using an estimate of the relationship between income levels and life satisfaction.
Wider Economic Impacts	Relate specifically to city-shaping projects where changes in urban density may change productivity.
Willingness to pay (WTP)	The maximum amount an individual or a firm is willing to pay for a good or service.
Willingness to accept (WTA)	The amount that individuals or firms are willing to accept in compensation for the loss of a good or service.

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